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Re-Integrating Food Systems: Development Potential?

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Re-Integrating Food Systems: Development Potential?

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Master of Arts in Global and International Studies

by

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ABSTRACT

Re-Integrating Food Systems: Development Potential?

by: Sara deFosset

This study looks at the potential of integrated food systems to meet sustainable development goals. Drawing on relevant literature and field research, it first explains the rationale behind integrated food systems for development, discussing the functionality, thinking and theory behind food system integration. It then looks at the cultural and historical context of the current food system in the chosen research sites of Central and Northern India. Turning next to policy, this work discusses how contemporary food systems in India, and in general, are shaped by agricultural policy, and how policy frameworks may be re-configured to better incentivize integrated food systems. This is followed by a general discussion of several issues related to integrated food systems for development: consumption, gender, participatory approaches and spatial and temporal scales. This paper argues that food system integration can help to achieve specific Millennium Development Goals, most notably reductions in poverty and hunger and environmental sustainability. The researcher concludes that if properly supported by favorable policy measures, funding, and public perception, integrated food systems have the ability to contribute to the achievement of sustainable development goals. Finally this paper concludes by identifying areas where further research is needed and recommending specific policy measures which could be utilized to incentivize the wider adoption of integrated food systems.

CONTENTS

PROLOGUE

This study raises very large questions. Some, including the central question: ‘In which ways and under which circumstances do integrated food systems help to meet sustainable development goals?’ and others: ‘What are advantages and disadvantages of integrated food systems for development?’ and ‘What factors enable and encourage the implementation/ utilization of integrated food systems and which factors discourage and prevent them?’ are generally answered. Others: ‘What is involved in ‘up-scaling’ integrated food systems to meet needs at increasing scales (household to global)?’ prove more difficult and remain largely unanswered.

Because of its limited breadth this paper has a tendency to present only part of the complete picture of integrated food systems for sustainable development. For example, the principal focus of the literature review is on how horizontal- that is, on farm- integration can improve sustainable development, largely leaving out the issue of vertical integration. This paper primarily focuses on food production, giving only limited treatment to the critical issue of consumption patterns for sustainable development. The issues of consumption and scale, while not fully developed are examined in the concluding discussion section of this paper. The time frame of this research was relatively short, 6 months, and as such its results must be understood as limited and preliminary. It is hoped that rather than providing definitive proof of the development potential of integrated food systems, this study will serve as a jumping off point for more targeted research into the specific contributions of integrated food systems to the ideals of sustainable and human development and the launch and scaling-up of successful pilot projects and action plans in the future.

The basis of this research is a long personal history of work with plants and plant systems. Many of the observations are empiric and based on study that extends beyond the scope of the research presented here. The field research for this paper was approached from the perspective of interest in complex and integrated systems, their functioning and capacities. The related recommendations for development should be seen as secondary to the observations and discussions of the potentials of integrated food systems themselves. To ground my prior understanding of the subject of food systems integration and integrated food systems for development and food security, I began this research project by participating in two immersive learning courses.

The first was a Permaculture design certification intensive through Santa Barbara City College. In this course I became familiar with the theory and practice of Permaculture design, one method of food system integration. Many of the general discussions of ecosystem approaches to agriculture, food and systems approaches to development are derived from knowledge gained through participation in this course.

The second course took place on site in Wardha, Maharashtra, India. It was held at Dharamitra an Eco-Technology Research Centre for Sustainable Development and working organic farm. The course work for this learning module, presented as part of the immersive learning program at the Sustainability Institute of University of Stellenbosch, South Africa, served to deepen my primary understanding of food system functioning and introduced me to the intricacies of local production and supply chains. Central themes of this course were: food and nutrition security, responses to globalized food systems, appropriate government policy frameworks, urban food security and food systems complexity. Perhaps more valuable than the course work was the opportunity to conduct research based on participant observation. The observations made and the conversations conducted via participation with the local food system during this period in August 2013 in and around Wardha serve to ground this research in the lived experience of rural agricultural communities in India.

The Indian context provided fertile ground in which to root my study of integrated food systems for development. Despite the richness of context, a larger theme of this paper bears mentioning here.

At the inception of this research, numerous research sites were envisioned, none of which were in India. In the end the choice to site this research in India was largely happenstance, and was based more on opportunity, and connections that allowed for access to the necessary informants, than on a pointed interest in Indian agriculture. While integrated food systems are, by nature site specific, the general principles of integration and the use of ecosystem approaches to food production are universally applicable. These principles represent a tool set for system design that can be accessed and applied in various ways depending on circumstance. I argue that food system integration has the same potential to improve food and environmental security, to a large extent, regardless of context. Because of the universality of the subject matter India was, in a sense, as good a place as any other for the execution of this study.

That being said, India presents a unique picture of food system integration for development and the specific character of its current food system should not be disregarded. Traditional agriculture in India has been practiced continuously for thousands of years and as such contains a wealth of time tested knowledge regarding beneficial use of complexity and integration in farming systems and food traditions. The continuity of Indian agriculture, taking different forms in different places, has contributed to the development of deep and ancient food traditions and diverse cultural identities linked to food systems. The Indian sub-continent was blessed with dramatic, varied, and productive landscapes resulting in equally dramatic and varied food systems. Furthermore, India is at a fascinating and unique period in its development. Having experienced rapid growth in recent decades, India has succeeded at lifting millions out of poverty and in creating a growing middle class, contributing to dramatic changes in consumption habits and production systems. Rising inequality has accompanied rapid economic growth and the wealth disparities between different segments of Indian society are becoming increasingly pronounced. With more than 17% of the global population (The World Bank , 2014a) India is emerging as a major power in the geopolitical sphere. In December 2013 it made history at the conclusion of the Doha round of trade talks, by successfully opposing western powers and defending its agricultural subsidy and expansive government food programs.

Although this research was conducted across three Indian sates: Maharashtra, Punjab, and Uttarakhand, special attention is given to Punjab. As the locus of the green revolution in Asia, Punjab provides an excellent arena in which to examine the effects of agricultural intensification, and the potential for integrated food systems to meet food related development goals. A focus on Punjab allows for the exploration of contrasts within the topic of IFS for development. In this state, small traditional farms exist alongside large industrial ones, demonstrating various levels of integration. Punjab is the wealthiest state in India based on per capita income. In comparison to other regions it is extremely developed and its urban, middle class, consumer culture is well established. At the same time it is the most agriculturally productive state and farming and related activities remain the main occupations in the region. This tension between ‘modern’ and ‘traditional’ both between urban and rural areas and within agriculture itself paints a rich picture of agriculture and food systems in the context of development.

As an amateur famer myself, and someone whose livelihood has, at various times, depended on the successful growth of plants, I am all too aware of the difficult nature of the recommendations made in the following report. Any shift in the structure of food production will of course be fought by difficulties (as change always is) and are most certainly easier said than done. It should be noted also that this research project does not escape the problem of pretentiousness in development; the “insurmountable arrogance of intervening in other people’s lives” (Nederveen-Pieterse, 2010: 161). It is hoped that India, in the context of this paper, will be taken as an example, a case upon which the foundations of the central argument (that IFS can contribute to the achievement of numerous sustainable development goals) can be tested.

In all cases development can be understood as a process of social learning, in which trade-offs and details must constantly be considered and re-worked. In this conception of development paradoxes, such as the “antimonies between measurement and meaning, between intervention and autonomy, or between the local and the global, must be acknowledged” (Nederveen- Pieterse, 2010:161). Regardless of their universal applicability, in all cases IFS will only be successful at meeting general, large scale needs, if rooted in place and the specificity of locality. All food systems are deeply imbedded in the cultures they inhabit. Further, through the course of this research it has become clear that long term solutions to the problems of sustainable development will have to be grounded in lived experience, greater systemic awareness, participation, culture and place based knowledge systems, and will have to combine top-down (financial and managerial) and bottom up (grass roots) approaches and projects. Perhaps farmer and poet Wendell Berry describes it best:

> Cultural solutions are organisms, not machines, and they cannot be invented deliberately or imposed by prescription. Perhaps all that one can do is to clarify as well as possible the needs and pressures that bear upon the process of cultural evolution and development. Ways of life change only in the living
>
> (Berry, 1996: 131).

INTRODUCTION

This research is an exploration of the potential that integrated food systems have to facilitate economically, environmentally, and socially sustainable development. The study looks at which factors encourage and enable food system integration and which factors discourage and prevent it. By analyzing examples and data gathered from food systems in Central and Northern India this paper examines how the potential of integrated systems may be better realized to meet development goals.

Recent reports indicate that the potential of complex, integrated food production systems for addressing issues of poverty, food security, and environmental sustainability, is under-realized. A study released by the Food and Agriculture Organization of the United Nations in 2011 states: "Agricultural systems can no longer be considered only as simplified input–output systems, but as systems that function best when the nature and interconnectedness of the various ecosystem components and functions are recognized and fully utilized as the basis of all forms of agriculture" (FAO, 2011a: 12). To meet human and environmental needs in the coming decades, agriculture will have to dramatically increase productivity while simultaneously reducing its ecological footprint. In light of this pressing concern, food system integration is gaining currency as a means of addressing issues of poverty, food security, eco-system destruction and the sustainable intensification of agriculture.

Mainstream development models that favor industrialized food production overlook the systemic nature of agriculture and the problems confronting its sustainable intensification. The over-simplification of agriculture, largely due to increasing industrialization and urbanization in the 20th century, has compromised the ability of ago-ecosystems to maintain and increase productivity. Development strategies have consistently failed to recognize the problem solving potential of complex, integrated systems. Nowhere is this failure more apparent than in contemporary food systems.

Integrated food systems are modeled on and embedded in ecosystems which deliver 'eco-system services'. The services delivered by eco-systems are many, function at all scales (from local to global), and are critical to the survival of all life on earth. It is argued that if humanity were to meet more of its provisioning needs (food and agriculture) through the use of 'free' eco-system services there would be positive and cascading effects for all three pillars of sustainable development economic, environmental, and social. It is further argued that greater integration in food production systems will yield many of the public and private benefits of wild ecosystems and could be employed to address a number of the problems associated with conventional agriculture.

Many models for integrated food production already exist and are practiced throughout the world. These systems often are, or resemble traditional and indigenous land use practices, many of which have been in continual use for thousands of years. Despite the ancient history of food system integration, the use of integrated systems to meet globalized economic, environmental and food security needs is relatively new. Throughout the world development and the progressive march of modernity have meant urbanization, industrialization of agriculture and the disintegration of many traditional, cultures of place and local food systems. In India, where rapid growth has meant a growing rift between modern and traditional lifestyles, these changes are apparent. These cultural and contextual dynamics have profoundly shaped contemporary Indian food systems and rural economies, contributing to a lack of understanding for traditional, integrated food systems in the public consciousness, and presenting a further obstacle to their wider adoption.

In India, national food security is the singular goal of agricultural policy. The Indian government ensures food security through a system of price supports for the production of staple food grains, primarily rice and wheat. This singular focus has served to de-incentivize more diverse and environmentally sound farming techniques. While there is no doubt that India must remain vigilant about food security and support for poor farmers, it must also begin to address many of the social and environmental issues associated with its current policies which promote conventional, monoculture production. Today the goal of food security is increasingly underpinned by environmental sustainability. In order to provide for national food security in the long term, Indian agricultural policy will have to broaden its policy objectives to include environmental and social concerns.

Indian policy makers may look to European agricultural policy which, in response to similar problems, transitioned from a system of price supports to a system of direct payments to farmers. Direct payment systems, as opposed to price support linked to production, have the flexibility to incentivize multiple objective in agriculture including food security and environmental sustainability. It is likely that such a system could be used to improve the productive continuity and sustainability of Indian farming systems and promote wider food system integration.

This research finds that integrated food systems provide clear benefits in terms of sustainable development objectives. However, their wider implementation and ability to effectively contribute to development in the 21st century is constrained by a number of obstacles. Chief among these is public perception and serious concerns over the ability of these systems to meet large and growing global food needs. Poor public perception contributes to a lack of research and development into the full potential of integrated food systems. Lack of knowledge and understanding has the effect of maintaining the 'status quo' in terms of agricultural policy, creating policy environments which are discouraging to eco-system approaches. It is clear that substantial new research will be needed in order to assess how best to capitalize on and expand the benefits of integrated food systems.

Despite its limited scope, this study is intended to provide a framework through which to examine the potential of these systems for facilitating sustainable development and how their potential may be better realized. It is hoped that this report will deepen the understanding of ecosystem based approaches to sustainable food systems for development, will contribute to mainstreaming more holistic, effective, and sustainable development paradigms, and will perhaps even allow the reader to pose larger questions about human connections to natural systems and what these connections mean for development as a whole.

RESEARCH QUESTIONS

Thesis Question:

In which ways and under which circumstances do integrated food systems help to meet sustainable development goals?

To answer this thesis question, the following sub-questions must be addressed:

i. What are advantages and disadvantages of integrated food systems for development?

ii. What factors enable and encourage the implementation/ utilization of integrated food systems and which factors discourage and prevent these systems?

iii. What is involved in ‘up-scaling’ integrated food systems to meet needs at increasing scales (household to global)?

WHY INTEGRATED FOOD SYSTEMS?

The untapped potential of integrated food systems (IFS) to address the three pillars of sustainable development (economic, social, and environmental) is only recently becoming recognized by policy makers and development actors. The growing currency of integrated food systems can be seen throughout development literature and coincides with increasing awareness of the urgent need to 'sustainably intensify' food production in order to meet growing global needs. Recent policies and action plans (Convention on Biodiversity (CBD) 1993; The European Commission's new Common Agricultural Policy (CAP) 2003; Biodiversity for Food and Agriculture UN FAO 2011; The Great Green Wall Initiative, GEF 2005; Climate Smart Agriculture, Scherr 2012 etc.) reflect a shift towards more holistic approaches to agriculture and food production. In their recommendations for action these programs and documents are very much in line with realizing the potential of integrated systems for meeting sustainable development goals, including global food security.

There exists a wide body of literature which speaks to the central question of this study, how IFS may be able to meet sustainable development goals. However, subsequent questions are raised that extend beyond the limited scope of this research (such as issues of scale and consumption) and are given brief treatment in the concluding discussions of this paper.[1] This section examines relevant literature in order to shed light on the relationship between specific food production systems and sustainable development outcomes. First, to get at these questions, let us turn to the general concept of sustainable development, how it has evolved and what it means today and in the context of this study.

[1] See Discussion, Conclusions & Final Thoughts pg. 116

Sustainable Development: Major Trends

It would appear that 'Sustainable Development' is a continuously evolving and not yet fully mature concept. Contemporary conceptions of sustainable development have their origins in the early environmental movement of the 1960s and 1970s. Concerns over the 'Limits of Growth' (Club of Rome, 1972) were formally inscribed in the 'Bruntland Report' issued by the World Commission on Environment and Development (WCED) in 1987, which contains the most commonly quoted definition of sustainable development: *"*development that meets the needs of the present without compromising the ability of future generations to meet their own needs" The report was seen by many as an attempt to "reconcile the ecological 'limits of growth' articulated by the northern green movement since the early 1970s, with the need for growth to eliminate poverty as articulated by developing countries in the south" (Swilling et al., 2012: 26).

The WCED report "provided the strategic foundation for the 1992 Rio Earth Summit, the World Summit on Sustainable Development in Johannesburg in 2002, and numerous international policy conferences between 1972 and 2002, in addition to a new literature on sustainability, sustainable development, and the emergence of a field formally designated 'sustainability science' " (Swilling et al., 2012: 26). A number of research reports are identified as having been seminal in solidifying conceptions of sustainable development, these include: The UN Millennium Ecosystem Assessment (MEA), 2005; Reports by the International Panel on Climate Change (IPCC); The International Energy Agency's World Energy Outlook, 2008; The UNDP Human Development Report, 1998; and the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), 2007 (Swilling et al., 2012: 27).

Despite its emerging pertinence in mainstream development discourse, clear definitions of sustainability and sustainable development remain contentious. The attempt to establish a set of general and universally applicable principles and targets for sustainable development is reflected in the Millennium Declaration adopted by the 189 member states of the UN in 2000, which set forth the Millennium Development Goals (MDGs).

Many had hoped that the Rio + 20 summit of 2012, the 20 year follow up to the 1992 Rio Earth Summit (United Nations Conference on Environment and Development (UNCED)), would result in the replacement of the MDGs with a new set of SDGs, or Sustainable Development Goals, providing “a critical reference point against which to measure progress on sustainable development. Substantively SDGs would build on the MDGs, but cover the environmental dimension more explicitly. The reason why countries were able to adopt the MDGs was that they do not specify which policy instruments countries should use; SDGs would likely be designed the same way” (Clémençon, 2012: 332). However, efforts to establish SDGs proved more factious than imagined.

Even though understandings of sustainable development vary widely there are several generally accepted commonalities to most definitions. The ‘three pillars of sustainable development’ or the ‘triple bottom line’ approach to development is salient in sustainable development discourse. “Rio+20 officially defines sustainable development as composed of three dimensions that must be pursued simultaneously: economic, social, and environmental. Paragraph 3 of the document produced by the Rio +20 conference entitled *The Future We Want*, describes the need to further mainstream sustainable development at all levels, integrating economic, social and environmental aspects and recognizing their inter-linkages, so as to achieve sustainable development in all its dimensions” (Clémençon, 2012: 312, 317). Definitions of sustainable development generally hold that development must be sustainable:

> <u>Economically:</u> Development consistently (over time) provides the monetary resources to meet basic needs like food, shelter, health and education
>
> <u>Socially:</u> Development consistently provides access to social resources such as health care, education, and participation in governance. It provides the necessary social conditions for communities and individuals to engage in the free ‘pursuit of happiness’.
>
> <u>Environmentally:</u> Development does not compromise the ability of ecosystems to function and provide services and may improve their ability to do so

The original conception of sustainable development was borne out of the realization that ‘development’ must include objectives beyond economic growth. Since the early 1990s it has been expanded even further to include more nuanced ideas about human and environmental well-being, and the interrelated nature of development problems, which were once considered separately (poverty, hunger, environmental degradation, economic growth etc.). The establishment of the Human Development Index and other measures of development, including happiness (Bhutan’s Gross National Happiness Index), diversity (The Convention on Biodiversity including bio-cultural diversity), and the relationship between ‘human well- being’ and ecosystem health (The Millennium Ecosystem Assessment), as priorities for development indicate a paradigm shift within development thinking away from linear conceptions of industrialization and growth towards more detailed, systemic and holistic views of development which prioritize human and environmental wellbeing. *The Future We Want* identifies "the human dimension of sustainable development as a key concern, evoking equity, peace, freedom, human rights, good governance, gender equality, participation of civil society" (Clémençon, 2012: 317).

It is also widely agreed that the central and overarching goal of development, including sustainable development, must be the eradication of poverty. In paragraph 2 of *The Future We Want* it states that "Eradicating poverty is the greatest global challenge facing the world today and an indispensable requirement for sustainable development" (Clémençon, 2012: 317). For development theorists "the challenge of sustainable development in the current global conjecture is about eradicating poverty, and doing this in a way that rebuilds the ecosystems and natural resources on which we depend for our collective survival" (Swilling et al. 2012: 46). The eradication of poverty and hunger is established as the first of the 8, generally accepted Millennium Development Goals.

In the context of this research sustainable development must acknowledge the systemic, interrelated and complex nature of development problems and address them accordingly. This study takes a 'complex systems perspective' on sustainable development, "depicting the three spheres (economic, social & environmental) as embedded *within* each other. The economy is embedded within the social-cultural system, and both are embedded within the wider system of ecosystem services and natural resources" (Swilling et al. 2012: 50).The Millennium Development Goals, established by the UN General Assembly in 2000, are simple, general and widely applicable. They fall short of describing the many nuanced aspects of sustainable development (the carrying capacity of the planet, subjective understandings of poverty, social and cultural relationships to health and food etc.) however their generality allows for the inclusion of all of these factors. “The eight MDGs guide the efforts of virtually all organizations working in development and have been commonly accepted as a framework for measuring development progress” (The World Bank, 2014b).

Because of their generality and their wide acceptance in the face of divergent definitions and interests, I take the MDGs, as the primary measure of sustainable development in this study, although I contend that integrated food systems are very much in-line with more complex definitions of the concept. Integrated food systems link directly with two stated Millennium Development Goals (MDGs): 1. “Eradicate extreme poverty and hunger & 7. Ensure environmental sustainability.” Several more are also related, and would likely experience positive effects from the implementation of IFS: “3. Promote gender equality and empower women, 5. Improve maternal health, & 4. Reduce Child Mortality” (UNDP, 2014).

To answer the question of how, and under what circumstances integrated food systems may help to meet sustainable development goals, I provide a clear definition of integrated food systems in the context of this research. The following section is intended to clarify understanding of the meanings and applications of integrated food systems for development.

Integrated Food Systems (IFS)

‘Food systems’ are the systemic relationships between and within the production, distribution, and consumption of food. Integrated Food Systems (IFS) are composed of the multi-functional systemic relationships between and within food systems. ‘Integrated’ systems make use of complexity and the interactions between system components to achieve functioning and are modeled on and embedded in natural ecosystems. This has led to their identification by international development partners, governments and civil society organizations, as ‘ecosystem approaches’ (UN.org). Key characteristics of IFS include diversity and multi-functionality. Other general characteristics are as follows:

- Integrated systems must have significant interaction (positive and/or negative) between components of the system, (ecologically and/or economically).
- Integrated systems are more complex (structurally and functionally) and/ or have longer cycles than ‘conventional’ systems.
- Integrated food systems have two or more outputs and/or minimal or no inputs.

Integrated food systems have existed throughout the world for thousands of years. They are very often based on, similar, or identical to indigenous, traditional, and pre-industrial land use practices. The multi-functionality of integrated systems has, today, been adapted to address multi-faceted development objectives. For agriculture and natural resource economist Sara Scherr, Integrated land management practices are “designed to achieve multiple objectives, including human well-being, food and fiber production, climate change mitigation, and conservation of biodiversity and ecosystems services” (Scherr et al., 2012: 3).

Scherr adds some additional characteristics to the definition of contemporary integrated food systems for development. IFS for development:

- Manage ecological, social, and economic interactions among different parts of the landscape to seek positive synergies among interests and actors and reduce negative trade offs
- Acknowledge the key role of local communities and households as both producers and land stewards
- Take a long- term perspective for sustainable development, adapting strategies as needed to address dynamic social and economic changes
- Employ participatory approaches to social learning and institutionalize multi-stakeholder negotiation, including efforts to involve all parts of the community and ensure that the livelihoods of the most vulnerable people are protected or enhanced (Scherr et al., 2012: 3).

There are many types of integrated food systems. They go by many names and are often variations of each other, overlapping and intersecting to create a complex web of integrated practices and methodologies which utilize the same basic ecological principals, or 'ecosystem approaches' to food production.

In the context of this research the term integrated food system (IFS) is used as an umbrella term to encompass all food systems that are characterized by the general principles described above. Examples of contemporary IFS for development include: Permaculture (Mollison et al., 1978: Permaculture One); Conservation Farming (UN FAO, 2014: fao.org/ag/ca/1a.html), Biological and Ecological Farming (Virginia Association for Biological Farming, 2014: vabf.org & Greenpeace.org, 2014), Biodynamic Farming (Biodynamic Association, 2014), Holistic Land Management (Allan Savory, Savory

Institute) Agroforestry (International Center for Research into Agroforestry (ICRAF)); and Aquaculture.

In the context of this research the term IFS generally refers to food *production* systems (farms). An ‘Integrated food system’ then becomes a farming system in which individual components (livestock, crops, trees, water) have strong relationships and these relationships are utilized to maximize productivity. Occasionally the term ‘integration’ or ‘integrated food system’ is used to refer to levels of vertical integration. Vertical integration, like horizontal (farming system) integration, occurs when the relationships between system components (i.e. producer and consumer) are strengthened and utilized to maximize efficiency. For example: farmers who are engaged in onsite processing or who have developed their own markets for farm produce would be considered more vertically integrated than their counterparts who must seek these services externally.

The degree to which a system is considered integrated depends on the level of interaction between system components. For example: A rice farmer who also has dairy cows but does not make use of the cow manure to enrich soils and does not produce his own fodder would not be considered integrated. The farmer who does use the manure (reducing fertilizer use) and/or does produce his own fodder (reducing the need for external inputs (animal feed)) would be considered integrated. If the farmer only used manure but did not grow fodder, his farm would be less integrated than the farm that both used manure and produced fodder.

Integrated Food Systems for Development

> An enduring agriculture must never cease to consider, respect, and preserve wildness. The farm can exist only within the wilderness of mystery and natural force. That is what agricultural fertility *is*: The survival of natural processes in the human order. To learn to preserve the fertility of the farm, Sir Albert Howard wrote, we must study the forest

(Berry,1996: 130)

Ecosystem Approaches & Diversity:

The general concepts behind Integrated Food Systems (IFS) have their roots in ecology and in systems ecology particularly. Systems ecology is an interdisciplinary view of ecology that links such divergent fields as biology and economics by applying general systems principles. Integrated food systems are broadly based on ecological principles, with attention to relationships within systems. Integrated food systems situate human systems (like agriculture and food production) within, not separate from, or dominate over, natural systems.

The functionality of integrated food production systems derives from the natural functioning ecosystems. Healthy eco-systems provide invaluable 'eco-system services' to human communities at all scales, from local (purification of ground water on individual farms) to global (sequestration of carbon and mitigation of climate change). All life on earth depends on the continued provision of these ecosystem services. "Perhaps the most basic lesson of biological science is that all life is directly or indirectly dependent on the solar energy captured by green plants" (Holmgren, 2006: 27). Photosynthesis; the process by which plants- powered by sunlight, convert carbon dioxide and water into carbohydrate and oxygen; illustrates the subtlety and fundamental necessity of ecosystem processes. "In this context, agricultural systems can no longer be considered only as simplified input- output systems, but as systems that function best when the nature and interconnectedness of the various ecosystem components and functions are recognized and fully utilized as the basis of all forms of agriculture" (FAO, 2011a: 12).

Ecosystem services are part of a long and intricate evolutionary process of which humanity and human systems are also a part. This evolutionary process has led to systems which are "almost by definition, at maximum power and optimal efficiency" (Holmgren, 2006: 132). Modern agriculture, had dismantled complex, efficient and intricately evolved natural systems though the disproportionate valuation of provisioning services (food, fiber, fuel) over other services (regulating and cultural). It has successfully increased provisioning services by exerting control over ecosystems by way of simplification and the use of external energy inputs. By exerting control, this approach sets human systems apart from the natural systems and processes in which they are embedded and upon which they ultimately depend.

Puia et al. divide ecosystems in two categories, manmade ago-ecosystems, and natural ecosystems. Such a division highlights the inherent capacity for service provision in natural ecosystems which, in contrast, is lacking in human designed and controlled systems. "Natural ecosystems demonstrate a high degree of spontaneous self-organization, stability by means of eco-feedback, and a clear cut structural diversity. Unlike natural systems, manmade ones have no spontaneous self- organization; their stability is low because of the limited eco-feedback; their bio-chemical cycles are controlled, altered, even revoked by man, and their ecological diversity is very small" (Puia et al., 1995). Human control of ecosystems has led to dramatic increases in provisioning services (food and other products); however this control has been costly in terms of energy and has compromised the functioning of secondary services. Integrated approaches to food and agriculture are aimed at increasing the productivity of agro-ecosystems as a whole. According to the UN FAO "Total productivity of ecosystems and landscapes will become more important than yield per hectare of specific crops. The functioning of the system in terms of regulating and supporting services will need to be considered in addition to the volume of extractable products" (FAO, 2011a: 30).

Healthy ecosystems are in a constant state of flux, evolving and adapting to new inputs and new conditions. IFS design makes use of the evolutionary, adaptive capacity and natural self-organization of ecosystems. The practical utility of natural patterns of self-organization is highlighted by established traditional and indigenous land use systems throughout the world. These land use systems are compelling examples of food systems that meet human needs within the ecological capacity of re-generation, and can, therefore, be considered 'sustainable'. Because eco-systems respond quickly to human and other influences, and because these patterns of self-organization have been utilized throughout history to meet human needs, it follows that the diverse, adaptive, self-regulating power of ecosystems can contribute to the design of contemporary, sustainable human systems. With the increasing risk of environment related 'shocks' due to climate change and other factors, the adaptive capacity of healthy ecosystems, which depends on diversity, is becoming particularly important.

Like natural ecosystems, integrated systems demonstrate a ‘clear cut structural diversity’ which serves a variety of functions. The value of integrated systems for agriculture, food and development, comes not from individual eco-system elements but from the interactions between system elements. In an integrated system “each element performs many functions and each important function is supported by many elements. Every element (living plants and animals) has many different characteristics, requirements, outputs and potential uses” (Holmgren, 2006: 155). Multi-functionality is a key aspect of integrated food systems. “Agriculture has multiple outputs and, by virtue of this, may contribute to several social objectives at once. In a normative sense multi-functionality is a desirable objective of economic activity (agriculture). The broader concept of sustainable development alludes to the multi-functional nature of agriculture” (Parra-Lopez et al., 2008: 539).

The widespread adoption of integrated food systems will require the consideration of the social, economic, and cultural functions of agriculture, in addition to its function as provider of goods and the “key role of local communities and households both as producers and land stewards must be acknowledged” (Scherr et al., 2012: 3). This view of agriculture is holistic and trans-disciplinary including both social and biological sciences. It is reliant on system integration and synergistic interaction within and across systems rather than on segregation, as is the case with in conventional, industrialized agriculture. “Such an approach involves recognizing the multifunctional nature of agriculture and the importance of considering the broad range of provisioning, regulating, supporting and socio-cultural services provided by agricultural complexity” (FAO, 2011a: 13).

Integrated food systems are, by nature, diverse systems. In integrated systems, as in nature, diversity of elements is necessary in order to maximize the potential number of functions, relationships and interactions between them. Recently, the significance of diversity for food and human systems, in general, has become more widely recognized. The 1993 Convention on Biodiversity, a binding international treaty – the first of its kind- aimed at the preservation of both wild and cultivated biodiversity, is a clear example of this. The UN FAO states that "The wider adoption of ecological approaches will depend on the capacity to develop sound eco-system wide, integrated frameworks grounded on the maintenance of diversity in production systems, including the human component of diversity (bio-cultural diversity)" (FAO, 2011a: 30).

Diversity is an integral component not only of environmental stability and provisioning services (including food), but also of livelihoods and economies especially in rural areas where agriculture is the dominant economic activity. "Having a portfolio of diverse food and income sources, from crops, livestock, trees, and non-cultivated lands can cushion households and communities from climate and other shocks" (Scherr et al., 2012:5).[2] Nutrition security (quality of diets) and, increasingly, food security as well, depend totally on diversity, and of course "culture" in many senses also grows out of diversity. Following the UN FAO: "Biodiversity underpins food security, sustainable livelihoods, ecosystem resilience, cropping strategies for climate change, adequate nutritional requirements, insurance for the future and the management of biological processes needed for sustainable agricultural production" (FAO, 2011a: 6). Viewed in this light the critical role of diversity for sustainable development comes into sharper focus.

[2] See 'Livelihoods & Labor' pg.73

Prior to the agricultural industrialization, which took place throughout the 20th century in many parts of the world, traditional farmers cultivated innumerable varieties of food and other crops. Today, in areas where industrialized agriculture has become well established (North West India, the USA), these thousands of varieties have dwindled to only a few 'improved' varieties of marketable produce.[3] Historically pre-industrial or 'traditional' societies have made use of diversity in livestock and cropping systems to ensure security and continuity of food production and buffer against risk. "General diversity in farming systems is essentially oriented towards risk–reduction. The temporal and spatial distribution of both crop and livestock production exploits and re-distributes risk of failure over a range of ecological zones providing a diversified economic base. Poly-culture is often seen as a traditional strategy that promotes diet diversity, yield stability, reduced insect and disease incidence, the efficient use of labor and the intensification of production with limited resources" (MacDonald, 1998: 297).

Although IFS employ 'traditional' practices most designers and practitioners would agree that IFS are not 'anti- technology or innovation'. Instead, the principle of diversity lends its self to innovation in the sense that diversity- that is, multiplicity- allows for the pursuit of the best possible path or solution, among many. In this way diversity and multi-functionality, implicit in most 'traditional' agricultures, facilitate innovation and efficiency. Many traditional farming practices can be applied and adapted fit the needs of contemporary farming situations. From an evolutionary perspective, changes in technologies, innovations and new methods are logical iterations of an ever evolving relationship between human and natural systems; however, the appropriateness of new technologies will depend on diversity

[3] See 'The Green Revolution & its Repercussions' pg.63

of available options. For American Farmer, Author and Activist Wendell Berry, “the strength of agriculture is in diversity of technology as of other things.” Integrated food systems are *not* necessarily low tech, or even organic but rather make use of diversity and system complexity to pursue the greatest possible productivity with the least application of external control. To engage honestly in this pursuit requires diversity of system components, technologies and methodologies. Unfortunately, according to Berry, “the present orthodoxy ignores the principle of diversity altogether” (Berry, 1996: 201).

The benefits of ecosystem based approaches to agriculture, which depend on and make use of diversity, are evident and potentially far reaching. The Food and Agriculture Organization of the United Nations states that: “the contribution of biodiversity for food and agriculture to improving food security and sustainability needs to be considered not only in terms of the role of diversity of various components but also in terms of how integrated systems that capitalize on interactions between components can strengthen productivity, resilience, adaptability and sustainability of agro-ecosystems at meaningful scales” (FAO, 2011a:13). The multiple functions (provisioning and regulating), maximization of output and minimization of inputs, the self-organization, the adaptability and resilience that are intrinsic to integrated food systems are clear benefits which speak to their potential for addressing some of the key issues of sustainable development including poverty eradication, food and nutrition security and environmental sustainability. Nonetheless, these potentials remain under-realized. Perhaps the best way understand how and why is to contrast IFS with conventional food systems.

Why Change? Conventional Agriculture:

The negative repercussions of highly productive, industrial agriculture (or conventional agriculture as it is referred to in this paper) are well known, and the associated harms to health, environment, bio-diversity and traditional livelihoods are well documented. These negative consequences bear discussing here, inasmuch as they highlight the ways in which integrated food systems are different from conventional ones and are, in their fundamental differences, better equipped to address sustainable development goals related to food. Conventional food systems and the industrialization of agriculture have, until now, been enormously successful at increasing food production and decreasing hunger in many parts of the world. However, this success has been predicated on cheap and readily available supplies of energy and inputs. Today as populations grow and urbanize, as consumption habits change and energy costs rise, conventional food systems that rely on heavy inputs are becoming less viable economically and environmentally. Further- the negative externalities created by these systems threaten their own long term productive capacity. What follows is a discussion of how the current, conventional food systems, in many parts of the world - certainly in my field sites of Central and Northern India- undermine the ability of countries to meet their sustainable development goals.

It has been well argued that contemporary agriculture is not working. According to the United Nations Food and Agriculture Organization: “Agriculture needs to change. It must become increasingly sustainable at the same time as meeting society’s goal of providing sufficient, safe and nutritious food” (FAO, 2011a: 8). Research indicates that global food systems are reaching a tipping point where the harms created by conventional agriculture are beginning to outweigh the initial benefits of increased productivity and efficiency. The consequence of dramatic yield increases achieved in the short term, seems to be declining productivity in the long term. The issue of declining productivity due to soil and water table depletion, pollution, and salinization, among other causes, which result from conventional food production practices, is likely to become more pronounced as societies struggle to achieve the productivity gains necessary to feed growing populations with consumption habits shifting towards red meat and processed foods.

Simplification and Segregation:

> This attempt at total control is an invitation to disorder. And the rule seems to be that the more rigid and exclusive is the specialist's boundary, and the stricter the control within it, the more disorder rages around it. One can make a greenhouse and grow summer vegetables in the wintertime, but in doing so one creates vulnerability to the weather and the possibility of failure where none existed before. The control by which a tomato plant lives through January is much more problematic than the natural order by which an oak tree or a titmouse lives thought January. Patterns of cooperation are safer than mechanisms of exclusion, even though they lack the illusory safety of 'control'.
>
> (Berry, 1996: 71)

A key characteristic of conventional agricultural systems is simplicity. And it has been argued that oversimplification of inherent complexity is, perhaps, the biggest shortfall of conventional agriculture. When we compare a field of a single crop like corn (monoculture), to wild eco-systems like forests, the simplification implicit in conventional production systems becomes clear. From one point of view, the simple intent of agricultural industrialization was to produce more food. The singularity of this intent has eclipsed other functions of farming and production of extractable, marketable products has come to be seen, during the 20th century, as the only meaningful function of agriculture. Industrialization has largely removed multi-functionality and the multiple roles of food systems from agricultural planning and discourse. For MacDonald, agricultural simplicity, as part of the "modernist paradigm of rationality and economic growth, subscribed to by development actors" conflicts with multi-functionality in agriculture contributing to "the normalization of modern, large-scale agriculture as rational" (MacDonald, 1998: 287). Subsequently, "much of the agricultural research conducted over the last decades has been concerned with increasing productivity through increased control of inputs and management of the production environment in ways that render it simpler and more uniform" (FAO, 2011a: 60).

The sharp focus on the provisioning services of agro-ecosystems (food and other extractable products), prompted the segregation of farm elements into separate territories both spatially and temporally. Simplification and segregation allowed for greater human control of food systems and it was precisely this specialization and control that enabled the dramatic efficiency gains and subsequent yield increases achieved during the 20th century. According to Ecologist David Holmgren:

> Simplification is the human default response to systemic problems. By eliminating the apparently less important elements involved, we reduce the complexity of management. When the elements are essential or too powerful to eliminate, we often resort to a strategy of segregation. Simplification and segregation tend to go hand in

hand. These are valid but overused strategies for dealing with excessive complexity (Holmgren, 2006: 163).

Through specialization tremendous productivity gains have been achieved but at the cost of system complexity and secondary services from agro-ecosystems. Symbiotic ecological processes which deliver a multitude of services depend on diversity and complexity and break down in its absence. Most of the negative repercussions of conventional agriculture are associated with the breakdown of these processes (nutrient cycling, water purification etc.) As eco-system processes underpin all agricultural productivity, conventional agricultural systems which depend on simplification and control threaten their own continuity. In the absence of the myriad functions that individual system elements (like crops) connect and depend on, monocultural productivity is maintained via the heavy application of external, fossil fuel based, inputs (fuel, chemicals, machines).

External Inputs & Vulnerability to Shocks:

The elimination of natural processes (pollination, pest control, nutrient cycling, soil building) through the simplification of agriculture in conventional systems, creates a need for external inputs to fill the gap. This is a cyclical problem whereby application of chemical inputs further degrades natural systems creating the need for ever greater applications of inputs. "The unintended effect of reliance on synthetic chemicals has consequences that are detrimental to the environment and the welfare of the human race. For example, high levels of nitrates, phosphorus and pesticides from agricultural activities are reported in many bodies of water worldwide, reducing their economic value and increasing health risks.

Further, conventional agriculture has encroached beyond its boundaries owing to the off-site movement of pesticides and fertilizers into other ecosystems, resulting in the destruction of habitats for both macro and micro flora and fauna" (Katsvairo et al., 2007:1). According to the United Nations this has to change: "Production practices based on a continuing and increasing dependence on external inputs need to altered. They are not sustainable, damage the environment, undermine the nutritional and health value of foods and lead to reduced function of essential ecosystem services" (FAO, 2011a: 8). Further, high levels of dependence on petroleum based external inputs (fuels and synthetic agro-chemicals) mean that food production and pricing is strongly influenced by energy costs. It has been shown that rising fuel prices translate directly to rising food prices, threatening food security, particularly for the poorest and most vulnerable. The growing expenses related to conventional farming due to dependence on costly, petroleum based inputs lends strength to the argument that not only environmental but also economic sustainability will require significant changes in approaches to food production.

In addition to the negative impacts for human and environmental health, and the rising costs of agricultural inputs, excessive use of inputs to maximize productivity in food systems ironically leads to declining productivity in the long term. Partly to blame for declining productivity in conventional agriculture is declining micro-nutrient content in soils. Most chemical fertilizers are composed of the three macro nutrients (Nitrogen (N), Phosphorous (P), and Potassium (K)) which are needed for plant growth. Excessive use of these chemicals have led to growing imbalances of soil nutrients with, vital micronutrients, Zinc, Iron, Copper etc. over used and under replenished. Further, in India, subsidy structures that are designed to finance agro-chemicals for farmers, have been adjusted, reducing subsidies for P & K, and creating strong incentives for the over use of nitrogen fertilizer. In an effort to reduce fiscal deficits "India cut by a fifth, the subsidy it gives to phosphate and potash-based fertilizers in 2012/13. Subsides to diammonium phosphate (DAP) and muriate of potash (MoP) fertilizers were slashed by 27.4% and 10% respectively. But it left out urea (Nitrogen), the most used crop nutrient" (Nayak et al., 2012).

Disproportionate use of nitrogen based fertilizers, exacerbates soil nutrient imbalances and leads to increased toxicity, vulnerability to pests and disease, and overall declines in productivity. According to Soil Scientist and Punjab Agricultural University Extension Specialist, Meherben Singh, over use of nitrogen fertilizer is a leading contributor to poor yields and disease outbreak in rice and wheat crops in Punjab. There is a perception that the greener a plant is (Nitrogen makes plants green) the better- but this is not true, and so farmers overuse nitrogen fertilizer which is bad for human, crop and overall environmental health (Singh, Meherben. 9/9/2013). Academic and sustainable farming activist Vandana Shiva explains: "Plants need more than NPK. High yielding plant varieties (HYVs)[4] , which now make up the majority of field crops in agriculturally intensive areas like Punjab, depend for their productivity on macronutrients supplied by chemical fertilizers. HYVs draw out macro and micronutrients from soils at a very rapid rate creating micronutrient deficiencies of zinc, iron, copper, manganese, magnesium, molybdenum, boron, etc. These deficiencies have effected productivity of rice, wheat, sugarcane, groundnut, oilseeds, and pulses in the Indian states of Punjab, Haryana, Andra Pradesh, Bihar, Gujarat, and Tamil Nadu" (Shiva, 2010: 114).

[4] See 'The Green Revolution & its Repercussions' pg.63

Excessive use of fossil fuel based inputs threatens agricultural productivity at local and regional scales due to the negative impacts on soil and ecosystem health, but it also represents a very real threat to food production at a global level as well.

> If you look at carbon dioxide from burning tropical rainforest, or methane coming from cows and rice, or nitrous oxide from too many fertilizers, it turns out agriculture is 30 percent of the greenhouse gases going into the atmosphere from human activity. That's more than all our transportation. It's more than all our electricity. It's more than all other manufacturing. In fact, it's the single largest emitter of greenhouse gases of any human activity in the world.
>
> (Foley, 2010)

It is widely held that climate change will likely have profound negative impacts on agricultural production worldwide. Agriculture, a leading driver of greenhouse gas emissions, will clearly have to change if climate change mitigation is to be seriously undertaken. In the context of climate change, and declining availability of 'cheap' energy, the use of excessive energy derived from fossil fuels, to simplify and control food systems becomes less viable and alternatives like IFS are increasingly called for.

System resilience in the face of changing climactic conditions is a pressing concern for today's food systems. To meet global needs, agriculture must become increasingly resilient to shocks both environmental (drought, heavy rains and storm damage, erosion, extreme temperature variation, new pests and diseases) and economic (raising costs of inputs, changing consumption habits). "As research and policy links between climate change and agriculture have advanced, climate-smart agriculture has emerged as a framework to capture the concept that agricultural systems can be developed and implemented to simultaneously improve food security and rural livelihoods, facilitate climate change adaptation and provide mitigation" (Scherr et al., 2012:2) In her paper *From Climate Smart Agriculture to Climate Smart Landscapes*, Agricultural Economist Sara Scherr observes that "the fundamental principles of climate-smart landscape approaches are similar to those of integrated landscape management more generally. Most of the practices and strategies that provide mitigation and adaptation are similar or even identical to those practices that lead to improved livelihoods and biodiversity benefits" (Scherr et al., 2012:12).

For example, the use of perennial plants is an integrated production practice that provides direct benefits in terms of climate change mitigation, improved livelihoods[5], and biodiversity in food systems. The ongoing selection for annual plants in conventional agriculture contributes to climate change and also vulnerability to climate related shocks. Mature and well-functioning eco-systems tend to be dominated by a diversity of deeply rooted, longer lived perennial plants like trees and shrubs. Most field crops are annuals, which in contrast, are by definition short lived and shallow rooted, leaving conventionally farmed landscapes extremely susceptible to erosion, loss of top soil, and salinization from excess water, not taken up by plant roots. Furthermore, short-lived annual plants do not provide the climate change mitigation services offered by woody perennials, which capture and store significantly more carbon. Scherr points out that "transition from annual crops to fields of perennials has been estimated to increase soil carbon by 50 to 100%"(Scherr et al,. 2012:3). According to the UN FAO "in order improve system resilience, food systems will

[5] See 'Livelihoods & Labor' pg.73

have to cultivate a wider range of plant species- both annuals and perennials- in associations, sequences, and rotations that can include trees, shrubs, pastures and crops" (FAO, 2011b: 31). In other words, integrated approaches to agriculture and land management, such as the use of mixed perennial plants, can simultaneously contribute to global well-being (climate change mitigation) and local, personal wellbeing (healthier environments and improved livelihoods).

The singular focus on monoculture production which has, largely in the name of food security, come to dominate 'modern' agriculture has blinded practitioners to the critical role of whole agro-ecosystems in supporting that productivity. Conventional food systems achieve tremendous productivity gains in the short term however their negative environmental impacts compromise productivity in the long term. In simplified production systems, the absence of agro-ecosystem functioning means huge quantities of energy must be harnessed to achieve and maintain productivity, making agriculture fundamentally unsustainable. Holmgren describes a "tension and balance in all cultivated systems between productivity and resilience. The cultivated system provides high yields, but is dependent on intensive management. On the other hand, the wild ecosystem provides low yields with little or no management" (Holmgren, 2006: 208). Integrated food systems strike the balance between provisioning services (food and other products) and regulating and cultural services (adaptability, resilience and aesthetic beauty) of agro-ecosystems.

The Food and Agriculture Organization of the United Nations describes "carefully designed, integrated management practices" based on diversity and eco-system processes which include "no-till and conservation agriculture, mixed crop- livestock systems with careful manure management, cropping systems with perennial and annual species, responsible use and storage of irrigation water and development of drought-tolerant crops" (FAO, 2011a: 22) as the practices most likely to ensure food security, environmental sustainability, and the urgent sustainable intensification of agriculture in the coming decades.

Critiques and Responses

The ecological benefits of integrated food systems are rarely disputed, and other benefits- economic and social are evident. International development literature describes the potential of IFS for making agriculture more sustainable as 'under-realized'. Nonetheless, IFS in their current position face numerous limitations for their scope and applicability, many of which have to do with scale, economic viability, and public perception. Despite these limitations I argue that IFS have the potential to contribute to sustainable development.

Complexity of management is one of the most obvious limitations of integrated food systems. According the UN FAO: "It has been argued that ecosystem approaches are labor and knowledge intensive and difficult for the farmer to manage and the consumer to understand" (FAO, 2011a: 32). Diversity in integrated food systems quickly complicates their management. This problem becomes evident when we consider the degree to which conventional farming systems are simplified in order to establish control and efficiency. To raise a conventional field of wheat a famer must understand only the particular cultural needs of wheat and will likely use machinery to aid in sowing and harvesting. In contrast, to raise a field of mixed crops and livestock, a farmer must understand the cultural needs of each element separately and each of the relationships between elements both positive and negative. It is unlikely that such a farm could be easily mechanized, indicating greater need for human labor, knowledge and attention. Additionally greater diversity of produce and outputs means more complicated, processing, storage, marketing and distribution of farm products. According to Punjab Agricultural University Agronomist, Dr. S.S. Walia, whose work examines the potential applications of integrated farming practices, "lack of knowledge and training is a big obstacle to greater integration. With bees, for example, a very specific type of care is required to maintain the hive, prevent swarming and produce good honey. This is work that must be done daily and takes skill and labor" (Walia, formal interview 9/19/13). Holmgren points out that "almost every farm has some potential to include enterprises as diverse as livestock husbandry, cropping, horticulture, aquaculture, apiculture and forestry in ways that increase the productivity of all the enterprises. Unfortunately, it is uncommon for one farming family to have the skills, capital, or even the cultural disposition to manage this diversity" (Holmgren, 2006:164).

For Walia, a farm need not include all of these enterprises to reap the economic and environmental benefits of integration. "Small farmers should grow crops to meet their own nutritional needs and then develop one or two additional industries or enterprises depending on their specific situation". For example, because vegetable markets are concentrated in cities, farmers near cities should focus on vegetable production; those near to sugar processing (of which there is much in Punjab) should focus on sugarcane etc. In this view gradual and/or partial re-integration of food systems eases complexity, increasing the likelihood that farmers could manage it to their advantage. According to Walia "Punjabi farmers are already using these systems since the vast majority combine livestock with their crops, 80% have cattle and many also have backyard poultry. The issue is that these elements should be better utilized as components of the overall farming system" (Walia, formal interview, 09/19/13).

In Walia's view, the problem of managerial complexity in integrated systems is not insurmountable. Based on his research he concludes that improved training and extension services and government support, in the form of low interest loans, would go far to promote the implementation of IFS. He points out that many of the practices that can positively impact the nutrition, health, and livelihood of rural communities, require no new infrastructure, investment or additional labor, such as the utilization of crop residues for the cultivation of mushrooms or the use or animal dung to create bio-gas. The issue, is that most conventional farmers are unaware of these practices and their benefits. Based on Walia's research it appears that the real problem of managerial complexity in integrated food systems is more a problem of information. If this knowledge gap could be closed then complexity of management would likely become less of a prohibitive factor for the wider implementation of IFS.

Integrated Food Systems, which rely on ecosystem functioning, are widely criticized for being 'low yielding' in comparison to conventional systems. American Biologist Norman Borlaug, best known as 'the Father of the Green Revolution' wrote in 1971: "If left to Mother Nature's whims we will harvest only one third or one half of the yield per unit of cultivated area that can be harvested using modern balanced technological practices." In response to the push for the wide spread adoption of organic agriculture he remarked: "crop losses would probably soar to 50% and food prices would increase 4 to 5 fold" (Borlaug, 1971). According to World Watch, an independent research institute devoted to global environmental concerns, "there is a long-standing argument that organic farming would yield just one-third or one-half of conventional farming" (World Watch, 2006). World Watch goes on to report on a study done by University of Michigan scientists in response to the concern that a large scale shift to ecosystem based approaches "would require clearing additional wild areas to compensate for lower yields" (World Watch, 2006). For Monsanto, industry leader in the manufacture of agro-chemicals and products including 'improved' seed varieties, the necessary increases in food production will come not from ecosystem approaches but from "advanced plant breeding and biotechnology" (Monsanto, 2014). Writing in 1995 Borlaug cautions policy makers and development practitioners against "succumbing to the illusions that food needs [in the developing world] can be met through the improved 'low-input, sustainable' systems that are based largely on traditional practices but require much more from farmers in terms of labor, knowledge, and skill" (Borlaug et al.,1995).

World Watch reports on a number of studies which find that organic practices were not as low yielding as critics suppose.

> There are actually myriad studies from around the world showing that organic farms can produce about as much, and in some settings much more, than conventional farms. Where there is a yield gap, it tends to be widest in wealthy nations, where farmers use copious amounts of synthetic fertilizers and pesticides in a perennial attempt to maximize yields. A seven-year study from Maikaal District in central India, for example, involving 1,000 farmers cultivating 3,200 hectares found that average yields for cotton, wheat, chili, and soy were as much as 20% higher on the organic farms than on nearby conventionally managed ones. Farmers and agricultural scientists attributed the higher yields in this dry region to [the use of integrated

> management practices] the emphasis on cover crops, compost, manure, and other practices that increased organic matter in the soils.
>
> (World Watch, 2006)

In considering the productive capacity of different food systems it is important to recognize wider socio-economic and environmental contexts and objectives. IFS sacrifice the productivity of individual crops for overall systems productivity and resilience. Dr. Navin Ramankutty of McGill University, co-author of a paper published in the journal *Nature* entitled "Comparing the Yields of Organic and Conventional Agriculture", points out that "yield alone, is only part of a range of economic, social and environmental factors that should be considered when gauging the benefits of different farming systems. This point is often overlooked in discussions of how best to feed the world. To assume that the best farming practice is the one that produces the highest yield is like observing that a Lamborghini outraces a bicycle, and thus should be the world's only vehicle" (LeVaux, 2012).

Given the multi-functionality of agriculture (food and other extractable products, regulating and cultural services) it appears that the perception of IFS as comparatively low yielding has more to do with how 'productivity' is measured than with any inherent limitations of IFS themselves. Measures of productivity are typically taken in terms of yields of individual crops. Vandana Shiva explains:

> Modern conceptions of farming reduce systems to individual crops and parts of crops. Crop components of one system are then measured with crop components of another. Since the strategy is aimed at increasing the output of a single component of a farm, at the cost of decreasing other components and increasing external inputs,

> such a partial comparison is by definition biased to make monocultures more productive when at a systems level, they may not be. No realistic assessments are ever made of the yield of the diverse crop outputs in mixed and rotational systems. Usually the yield of a single crop like wheat or maize is singled out and compared to yields of that crop from other systems or varieties. Even if the yields of all the crops were included, it is difficult to convert a measure of pulse into an equivalent measure of wheat, for example, because in the diet and in the ecosystem, they have distinctive functions. The complex and diverse cropping systems are therefore not easy to compare to simplified monocultures. Such a comparison has to involve entire systems and cannot be reduced to a comparison of a fragment of the farm system. In traditional farming systems, production has also involved maintaining the conditions of productivity. While these reductionist categories of yield and productivity allow a higher measurement of yields, they exclude the measurement of ecological destruction that affects future yields. They also exclude the perception of how the two systems differ dramatically in terms of inputs. (Shiva, 2010: 70-72)

The way that agricultural productivity is commonly measured biases the results in favor of industrial agriculture. Based on a 2002 study by the UN FAO, World Watch concludes that "yield comparisons offer a limited, narrow, and often misleading picture since farmers in developing countries often adopt organic or integrated farming techniques to save water, save money, and reduce the variability of yields in extreme conditions" (World Watch, 2006). For Shiva, "A true scientific comparison would be between two farming systems with the full range of inputs and outputs considered" (Shiva, 2010: 69). Here integrated systems are clearly the winner. Only with large inputs of energy is it possible to pursue the highest single yield. Therefore it appears that the perceived ‘low productivity’ or ‘low yield capacity’ of IFS is more what development theorist Jan Nederveen-Pieterse calls “a politics of measurement” (Nederveen-Pieterse, 2010:152), than an inherent weakness of integrated food systems. In its 2012 report Biodiversity for Food and Agriculture the UN FAO states that “Agricultural systems that are reliant on biological processes and on the natural properties of agro-ecosystems are often (simplistically) associated with low levels of productivity, poor farming systems and practices unable to respond to modern demands. However, they are also characteristic of a range of different innovative approaches to agricultural production that seek to combine productivity and increased farmer incomes with long-term sustainability” (FAO, 2011a: 51).

Today, in light of the costs of conventional agriculture, the benefits of integrated food systems are becoming more difficult to dismiss. Even the staunchest opponents, (Norman Borlaug, Monsanto) have been forced, in recent decades to acknowledge the utility of integrated practices. Monsanto, for example, is advocating “Integrated Farming Systems” (a term it seems to have trademarked) which make use of “environment-based yield potential”. For both Borlaug and Monsanto the term ‘integrated’ describes the carefully designed combination of organic and conventional methods to achieve the highest returns from agriculture in the most environmentally sustainable way possible. There seems to be a consensus forming around what has been called ‘the middle way’. According to agricultural extensionist Rowland Bunch who has worked for decades in Africa and the Americas, the benefits of integration “will come even without a complete conversion to a sort of organic utopia” (World Watch, 2006). For Jonathan Foley, Chair of Global Environment and Sustainability at the University of Minnesota, what is needed in order to meet the food needs of a growing global population is “a new kind of agriculture that blends the best ideas of commercial agriculture and the green revolution with the best ideas of organic farming and local food and the best ideas of environmental conservation, something he calls "terra-culture," or farming for a whole planet” (Foley, 2010).

Integrated food systems do not forswear technological innovation or, in contrast to organic methods, the use of agricultural chemicals, but make use of biological processes to minimize the need for inputs. When accurately measured, IFS do not have significantly lower yields, and so fit easily with agricultural approaches based on pragmatism which, independent of ideological posturing, simply seek to maximize food yields and minimize ecological impact. Given that these priorities are almost universally expressed and emanate from all points on the ideological spectrum, IFS present a real path forward for the necessary sustainable intensification of agriculture, particularly in the developing world. For the UN FAO “The very nature of sustainable production systems is dynamic: they should offer farmers many possible combinations of practices to choose from and adapt, according to their local production constraints and limitations” (FAO, 2011b: 9) “In the words of Danish Scientist Niels Halberg, who has headed studies by the International Food Policy Research Institute “It seems that agro-ecological systems [IFS] have a beneficial impact on yields and food insecurity. So why not seriously try them out?" (World Watch, 2006)

Similar to the concern expressed over the yield capacity of integrated food systems is a critique which revolves around scale. The UN FAO remarks: “criticisms [of food system integration] have been that it is economically impractical when it comes to large- scale implementation and will require even larger subsidies, or that required levels of production for an expanding world population could not be achieved” (FAO, 2011a: 32). Many critics fear that IFS, which are in many cases small scale, will not be able to meet large scale – read global- food needs, particularly if urbanization and population growth continue at their predicted rates. Writing in 1971, Borlaug points out "that modern agriculture with 3.7 billion people demanding food and fiber has no choice but to grow extensive areas to a single crop. This was not true 5000 years ago when there was less population pressure so that crops could be grown in small isolated fields" (Borlaug, 1971). It is safe to say that this concern is only more pressing today with the world population expected to reach 9 billion by 2050. I offer a two part response to this critique.

First; it is true that most IFS are relatively small scale. It is important to note that in order to achieve its current scale and speed, conventional agriculture has required huge inputs of energy. In situations with high energy availability it is possible to have large, fast-moving food systems like we see today with specialized, industrial farms and supply chains. Conventional farming systems do produce extremely high yields but those yields depend upon intensive inputs. This dependence limits their ability to meet rising food demand with available resources. In this light serious research into how to upscale integrated food systems which minimize energy dependence may be the sanest path forward.

Integrated food systems are modeled on and embedded in ecosystems. Typically an ecosystem system which is maximizing its efficiency will be large or fast but not both. It is conceivable that as the energy required to maintain and grow large scale industrial food systems decreases in coming decades, systems will have to shrink or slow down or both. In this sense approaches to food production, including IFS, which take into serious consideration ecological limits are calling a sort of 'down-sizing' of food systems. Smaller, slower systems have lower yields in terms of single crop productivity, but can be self-maintaining and even wild. If all food systems must necessarily become smaller and slower but more intensive, in order to meet the food needs of a growing world population, then well-developed networks of small Integrated Food Systems, shorter supply chains (with less need for speedy transportation and less opportunity for spoilage), and changes in consumption behavior are arguably better approaches to meeting global food needs than are intensification or expansion of conventional food systems that operate outside of the confines of available energy and the natural systems that support production.

The second part of my response has to do with the political structures that shape the current food system including research and development, and international development cooperation priorities. When considering the viability of IFS for meeting sustainable development targets, it is important to account for how available information, public perception, and the resulting policies effect food systems efficacy. Advocates and critics of IFS alike, point out that scale and productive capacity of food systems are only part of the food security equation, and that equitable food distribution is of equal importance. Nonetheless concerns over availability and affordability of food for all sectors of society continue to dominate agricultural research, development and policy. According to the UN FAO "these two major geopolitical realities have constraining effects on people's thinking and present a very real barrier to the development of new approaches to production" (FAO, 2011a: 9).

Conventional agriculture today is made possible by heavy government support, in most countries (certainly in the US and in India). Such policies distort markets, contributing to the perception that conventional farms are more productive than integrated ones, creating market barriers for small producers, and discouraging research into alternative methods. The

UN FAO also points out that “there is a widespread lack of awareness among everyone from policymakers to consumers of the importance of and need to adopt agricultural practices that enhance biological processes. Agricultural research over the last decades has not only generally ignored the potential value of biodiversity but has also been largely concerned with exploring approaches that simplify production systems and remove complexity and diversity; there is thus a need for substantial new research” (FAO, 2011a: 51). Even though these, and other reports demonstrate the clear potential of integrated food systems for meeting sustainable development targets related to food, many thinkers ask whether, ‘can sustainable agriculture feed the world?’ is even the correct question to be asking.

Following World Watch: “Even if a mass conversion [to integrated food systems], over, say, the next two decades dramatically increased food production, there's little guarantee it would eradicate hunger. The global food system can be a complex and unpredictable beast. Feeding the world depends more on politics and economics than any technological innovations” (World Watch, 2006). Indeed, immediate observation suggests that in most cases it is purchasing power and not insufficient food availability that is responsible for hunger today. Danish Scientist Niels Halberg of the International Center for Research in Organic Food Systems (ICROFS) observes: “Even if a shift toward organic farming boosted yields in hungry African and Asian nations, our model finds that nearly a billion people would remain hungry, because any surpluses are simply exported to areas that can best afford them” (World Watch, 2006). If this is the case perhaps the question of scale and yield capacity of various food systems is of only partial relevance and food security objectives would be better met through re-distributive policy action, and perhaps more importantly dramatic changes in food consumption habits, than through any sort of agricultural intensification. As Borlaug saw it:

> There are two key problems involved in feeding the world's people. The first is the complex task of producing sufficient quantities of foods to satisfy needs, and to accomplish this Herculean feat in environmentally and economically sustainable ways. The second task, equally or even more daunting, is to distribute the food equitably. Had the world’s food supply been distributed evenly in 1990, it would have provided an adequate diet (2,350 calories, principally from grain) for 6.2 billion people - nearly one billion more than the actual population. However, had the people in Third World countries attempted to obtain 30% of their calories from animal products - as in the United States, Canada, or Europe a world population of only 2.5 billion people could have been sustained, less than half of the present world population.
>
> (Borlaug et al., 1995: 117-18)

The perennial problem of complexity of management extends to governance and policy, and becomes more difficult at larger (global) scales. Due to their multi-faceted character, IFS tend to be governed by a plethora of diverse government agencies such as forestry, agriculture, and trade ministries. This means that at nearly all levels, implementation of IFS requires cross-sectorial cooperation. Globally, “at this time, funds for agricultural development, food security, environment, and climate change mitigation and adaptation generally come from different sources even though the activities supported by them are often inseparable on the ground” (Scherr et al.,2012: 13). This can amount to a total lack of governance since separate government ministries often have limited communication with one another and no single agency, in many cases, is willing to take responsibility for enabling and supporting integrated food systems. While a number of international organizations, such as the Global Environment Facility (GEF), do exist, which are designed to cut across these boundaries, their resource endowments are dwarfed by their huge mandates.

At large, even global scales organizational structures and funding for IFS become serious limitations. Many small scale pilot projects have been successfully implemented with funding from a diversity of sources including international development partners like the World Bank, and the GEF. However these projects appear to have reached an impasse with regards to up-scaling. Disciplinarity and compartmentalization of environment, food, and society in government, politics and public consciousness presents a clear obstacle to IFS in terms of funding, large-scale implementation and also research and development. For Norman Borlaug:

> Unfortunately, no matter how excellent the research done in one scientific discipline, its application in isolation will have little positive effect on crop production. What are needed are a few venturesome scientists who can work across disciplines to produce appropriate technologies and who have the charisma and courage to make their case with political leaders in order to bring these advances to fruition.
>
> (Borlaug et al., 1995:127)

"A common criticism has been that adoption of ecological approaches to farming reflects a romantic and backwards looking perspective" (FAO, 2011a: 32). Many of the critiques and perceived limitations of IFS seem to stem from a modern view of forward progress that sees non-linearity in temporality and design as regressive, a move backward. In response to alternative agricultural systems like IFS, Monsanto's website states: "Some people believe the correct answer to our challenges is to move backwards in time toward an agricultural system that relies less on human innovations and more on human labor" (Monsanto, 2014). Wilcox writes: "Organic farming tugs at our heartstrings, harkening back to a simpler time when life was rugged and man lived off the land. While it sounds like the perfect solution, the fact is our notion of organic farming is an idyllic fallacy" (Wilcox, 2012); And Norman Borlaug cautions: "Some sociologists, anthropologists, economists and other agricultural professionals envisage soil fertility strategies based on organic fertilizers, farmer-bred and maintained indigenous varieties, and biological or mechanical - but not chemical - control of all weeds, diseases and pests. But these 'low-input, low output' technologies tend to perpetuate human drudgery and the risk of hunger and misery. However much they may respect traditional farming practices, agricultural scientists must resist the temptation to romanticize them" (Borlaug et al. 1995). Clearly the concern being expressed is that romantic notions of pastoral idealism leading to a widespread shift away from modern conventional agriculture will drag humanity backwards in time to a point where the Malthusian poverty trap of declining food yields and growing populations will become a real possibility.

IFS seek, not to romanticize poverty and 'traditional' lifestyles - often based on subsistence agriculture - but rather to draw advice and examples from systems that have worked well in the past. For World Watch: "sustainable farming is a sophisticated combination of old wisdom and modern ecological innovations that help harness the yieldboosting effects of nutrient cycles, beneficial insects, and crop synergies. It's heavily dependent on technology-just not the technology that comes out of a chemical plant" (World Watch, 2006). Traditional food systems provide the IFS of today with a design template for systems which have historically achieved, essentially the same goals- to provide for people's food needs within ecological limits.

Most integrated food systems are more cyclical than linear in terms of temporality, (they combine ancient, traditional and cutting edge, modern methods) and design, (planting is not done in rows of even fields but is mixed, messy, and naturalistic often resembling a wild ecosystem). There is a critical "distinction between subsistence farming (which may be organic by default due to lack of resources, but not intentionally organic) and what Ramankutty, calls "intensive organic" or "integrated" methods, which involve active techniques" (LeVaux, 2012) like composting mulching, and intercropping. While, it does result in greater managerial complexity, the multi-functionality of IFS (increased and diversified productivity, regulating services and resilience), derives precisely from this nonlinearity. My response to the criticism that IFS are outdated or backwards looking is that they are precisely the opposite, providing tremendous opportunity for innovation. Approaches to agriculture which are based on the notion of constant linear progress (both spatially and temporally) ignore the multiple functions, potentials, and contemporary applications of time tested traditional methods and food system integration, which in the context of today's global food system, will likely be the best path toward meeting urgent food and sustainability targets.

Undoubtedly integrated food systems have some critical short-comings and limitations, many of which, labor intensity, transition periods, and corporate opposition, for example, are not fully elaborated on here. Based on the available literature, I conclude that many of the limitations of IFS not inherent but are due to lack of good research and development, lack of funding for R&D and implementation and, perhaps, most problematic of all is the school of public sentiment which views IFS as ‘backwards’, ‘outdated’ and ‘inefficient’, and upon which the actuation of research and large-scale implementation depend. Inasmuch as public policy is a reflection of public perception, the dismissal of IFS as archaic and obsolete leads to policy which inhibits the greater development of integration in agricultural systems and re-enforces negative perceptions and concerns over the viability of IFS.

In the context of change- rising energy prices, changing climactic conditions, degrading soils, water scarcity, urbanization, and a growing middle classes with growing middle class consumption habits- conventional food production becomes more expensive, less productive and thus less viable for meeting food security and sustainability needs in the long term. Clearly alternatives must be considered. In light of these changing conditions the limitations of IFS become less pronounced when compared to the limitations of conventional agriculture. For example, on industrial farms, large trees are often seen as taking up space which could be used to produce more marketable crop or livestock, and so most industrial farms have few large trees. However, in the context of climate change and declining soil fertility, the loss of additional marketable produce is compensated for by the services provided by large trees on farms in terms of carbon sequestration and soil building. In order to ensure that food remains available and affordable to all, integrated, ecosystem approaches which restore productivity, are more appropriate than conventional ones which deplete it and should therefore be given more serious consideration when it comes to achieving sustainable development goals related to food.

METHODS & EVIDENCE

In a general sense this research is a qualitative analysis. Because of the limited time and scope of the field research (4 months) it cannot be considered an exhaustive or complete ethnography of the people who inform this study nor is it a quantitative analysis of the costs and benefits of IFS in India or anywhere. This report draws heavily on the literature around food, agriculture and development in international policy and theoretical discourse, and also on my own empirical experience working with plants and food systems. This study utilizes **participant observation**, **Interviews** (both formal and informal), & **survey** methods.

i. Participant Observation:

- Dharamitra: Eco-Technology Research Centre for Sustainable Development
  Wardha, Maharashtra India (August 2013)

Dharamitra is a working organic and integrated farm and research center. It was founded by a group of local scientists and academics led by Dr. Tarak Kate of Wardha. The objective of the organization is to promote "sustainable development for the rural population by the application of eco-friendly technologies and the judicious use of natural resources" (Dharamitra). It does this by conducting research and development of new and appropriate technology, for example: small scale composting systems and cooking devices that run on renewable energy. It also helps local people to generate income through the development of agriculture related small industry including apiculture, mushroom cultivation, and production of paper and roofing sheets, and it promotes alternative cultivation practices like integration as a substitute for chemical inputs and the development of aromatic and medicinal gardens.

- Navdanya Bija Vidyapeeth: Biodiversity Conservation Farm & Learning Center Dehra Dun, Uttarakhand India (October 2013)

Navdanya (nine seeds) is a network of seed keepers and organic producers spread across 17 Indian states. Bija Vidyapeeth translated to ‘School of Seed’, is the biodiversity conservation farm and learning center of the Navdanya Organization whose primary purpose is the preservation of seed diversity as a way of also conserving culture and environment. Navdanya works towards its objectives by establishing community seed banks, training farmers in ‘seed sovereignty’, ‘food sovereignty’, and sustainable agriculture. It has established a system of direct marketing for the produce of Navdanya farmers which operates of fair trade principles.

In both Wardha (August, 2013 at Dharamitra) and Dehradun (October 2013 at Navdanya) I lived on small integrated farms. I was immersed in farm life and was able to observe and partially participate in the lived experience of small farmers in central and Northern India. On both farms I took part in daily chores and light farm work including, preparing and planting fields and kitchen gardens, preparing and applying seed treatments, cleaning and storing seed, mixing and applying natural fertilizers and pesticides, preparing compost, vermi-compost and vermi-wash, harvesting (rice and peanuts), cleaning and cooking produce.

By participating in daily farm work I was able to interact with my hosts and gain insight into their lives, however language barriers frequently prevented direct conversation or discussion about their subjective experiences with the food systems in which they were working and living.

ii. Interviews:

Informal: There were two types of interviews which I categorize as informal in this study.

1. Inteviews conducted in a group setting: Through participation in immersive course work (Dharamitra) and University Projects (Punjab Agricultural University) I had the opportunity to interview many people including farmers (both conventional and integrated), scientists, journalists, activists, business people, and corporate representatives. These interviews were conducted in a group. In these cases I was one of many people asking questions which were answered through a translator. The transcripts of these interviews often reflect divergent lines of inquiry as the informant was answering questions from many interviewers in addition to myself.
2. Semi-Casual Conversations: During the course of my investigation I spoke with many people about my work. Because of my access to local academics and policy makers, I engaged in many in-depth conversations on my research topic which were not formal interviews. Nonetheless these conversations inform the work presented in this study.

Formal: I consider formal interviews to be the conversations in which the informant agreed to an interview, sat down with me one on one, and answered a set of prepared questions with regards to IFS. In these cases interview questions were tailored to each specific respondent, and while the interviews were, in most cases, conducted through a translator the responses show more clarity than do other type's interviews in this study.

Informants for this study include farmers both integrated and conventional, business people and corporate representatives, policy makers and representatives of local governments, academics, activists, scientists and journalists. My interview questions focused on how integrated food systems were understood and implemented (or not). What allowed for their implementation or discouraged it, and what are the experienced benefits and drawbacks of food system integration socially, economically, and environmentally. Interviews usually took place during visits to farms or other research sites and most were conducted with the help of a translator. In all cases translators were local academics (Botanist and Ashoka Fellow Tarak Kate & Agricultural Economists and graduate students in Agricultural Economics at Punjab Agricultural University).[6]

iii. At the biannual Farmer's Fair (*Kisan Mela)* hosted by Punjab Agricultural University in Ludhiana, Punjab I had the opportunity to conduct a **survey** among farmers visiting the fair, all of whom were local and conventional. I was able to survey approximately 18 local farmers, over the course of two days. Survey questions centered on which farming practices were being utilized and what was being grown, size and ownership of the farm, level of debt, experience of farming and lifestyle, and hopes for the future.

[6] For list and description of informants see Appendix I, pg.134

Limitations:

There were several potential issues with data collection methods. Interviews do not necessarily reflect the perspective of all community members, or food system participants as language barriers and access prevented interviews with many people: for example women, consumers of niche products, and successful conventional farmers who did not have a need for University Extension Services.

Additionally the survey data, in particular, is of questionable validity as the chaos of the interview environment (in a crowd) prevented the clear administration of each question to each respondent and as a result some surveys are incompletely answered or are answered by multiple individuals.

In all cases, with the exception of literature review, language barriers affected data collection, and the use of translators likely skewed the data collected from informants in this study.

Research Ethics:

This research project was deemed ‘exempt’ by the Human Subjects Review Board. Verbal permission was attained from all named informants in this study.

FOOD SYSTEMS: HISTORY, CULTURE & CONTEXT

Of the questions presented in this study- perhaps the most revealing is: ‘what factors enable and incentivize food system integration and which factors discourage it?’. Through the exploration of this topic two main factors emerged as discouraging to IFS. The first is policy- in India (as in the US and elsewhere) price support policy has the effect of incentivizing simplistic monocultures. The second is culture. Clearly history and social understandings shape food systems. In the words of one Punjabi agricultural economist: “MSP (price support) is part of the story but there is a social aspect as well.”

Food systems are intimately related to all cultures. Throughout the world, development and the progressive march of modernity have meant urbanization, industrialization of agriculture and the disintegration of many traditional, cultures of place and local food systems. In India, where rapid growth has created a growing rift between modern and traditional lifestyles, these changes are immediately apparent. In order to get at how food systems are shaped by social and cultural context, and how the dynamics of context underpin sustainable development, this section turns briefly to an agricultural history of India from the time of independence. It gives special focus to Punjab in the North West. The argument then moves on to the implications of these rapid changes on local people and the agricultural economies that support them via discussions of livelihoods, labor, and the commercialization of agriculture. I conclude by exploring the intangible values of agro-ecosystems (cultural, spiritual, aesthetic) and the ‘cultures of place’ in which many of these values are embedded, drawing links between the cultural aspects of food systems in the Indian context and sustainable development goals.

A Brief and Narrow History of Agriculture in India Since Independence (1947)

India, with a history of famines in both pre and post-colonial times was once a food importer but public policy and innovation in agricultural technology (the Green Revolution) has changed that. Since the 1960s agricultural production in India, and specifically Punjab, has dramatically increased. Today India is a food exporter and can be considered food secure in terms of calories available from staple food grains.

The transition from traditional, subsistence agriculture in India, to commercial agriculture of industrial scale, oriented towards the market, began during British rule. Various factors led to the commercialization of agriculture during this period.

> India supplied raw materials and food grains to Britain and imported British manufactured goods. Many commercial crops like, cotton, jute, tea, tobacco were introduced to meet the demand in Britain. A significant feature of commercialization of agriculture in India was the substitution of commercial products in place of food. Between 1893/94 to 1945/46, the production of commercial crops increased by 85% and that of food crops fell by 7%. This had a devastating effect on the rural economy and often took the shape of famines.
>
> (Dialogue, 2012)

Commercialization of agriculture in India during British colonial rule was facilitated by an oppressive system of land settlement in which Zamindars, or landlords, collected taxes for the Raj and charged exorbitant rents to peasant laborers. “At independence, India was an overwhelmingly rural, agricultural, and impoverished country. Almost nine out of ten Indians lived in villages and depended on the meager yields of farming, mostly subsistence farming. In 1951, when India conducted its first census after independence, the country had a literacy rate of only 16%. Average life expectancy was just thirty–two years" (Luce, 2007).

From WWI to independence in 1947 Indian agricultural production was low, influenced by a web of complex factors including "reduced exports due to worldwide recession, depression, and the near complete paralysis of shipping during WWII" (Shiva, 2010:51). "India at independence was a country desperately in need of rural land reform and measures that would drastically boost crop yields so it could feed its people and build a launch pad for future growth" (Luce, 2007). By the time of independence the British had converted much of Indian agriculture to cash crops for export, pushing subsistence agriculture onto poorer and more marginal lands. The result was a decline in the production of food crops. The chaos of Partition (of the British Raj into India, Pakistan and Bangladesh at the time of independence) contributed to the decline in agricultural productivity. The massive population migrations that took place during this time led to a near 7% decline in the number of people engaged in agriculture nationally, contributing to mounting food instability in India (Bharadwaj et al., 2008: 5).

Following independence, Nehru's land reforms had "to some extent succeeded in getting rid of the most feudal end of the spectrum. The notorious Zamindari system had virtually been abolished by the end of the 1950s" (Luce, 2007). These reforms included ceilings on land ownership and fixation of reasonable rents for tenant farmers. The reforms offered some reprieve and agricultural output increased during the 1950s and 60s (Shiva, 2010: 51). In 1951, roughly 70% of the Indian population was engaged in agriculture (Bharadwaj et al., 2008: appendix). They typical farmer was cultivating traditional varieties of cereals and pulses on small land holdings. “In India, agriculture was the main source of national income and occupation at the time of independence. Agriculture and allied activities contributed nearly 50% to India’s national income” (Tripathi et al., 2009: 63). “Most of Indian agriculture was rain-fed except in the Northwestern region where irrigation canals were constructed during the colonial period (Punjab HDR, 2004). The, traditional, small scale Indian agricultural system at this time was growing increasingly ill equipped to meet national food demands. Despite its limitations, the Indian agricultural sector was growing modestly in the post-independence period. “Indian agriculture, grew at the rate of about 1% per annum during the fifty years before Independence, but grew at the rate of about 2.6% per annum in the post-Independence era”(Tripathi et al., 2009: 64). From independence to the time of the green revolution, growth was achieved primarily through agricultural expansion, or the cultivation of new lands.

India experienced a severe drought in 1966 due to two successive failed monsoons in 1965-66. Even before the droughts, demand for food outstripped supply. Between 1950 and 1965 there was a food grain shortage of 13,499 thousand tons, and rapid population growth was exacerbating food insecurity (Hopper, 1999). The droughts caused a serious drop in Indian food production, triggering a food crisis. This led to an unprecedented increase in food grain imported from the United States to deal with the problem in the short term. “A total of 54 million tons of American wheat were imported over the first fifteen years of India’s independence” (Shiva, 2010: 31). International aid was heavily solicited “to enable India to import food following the poor harvests. The joke was that India was living from “ship to mouth.””(Luce, 2007)

In this context, increasing agricultural production to meet national food needs became a central priority of the Indian government. To achieve the necessary gains, the government sought new production technology. “In order to achieve the goal of self-sufficiency in agriculture, a new agricultural strategy was initiated in 1966/67. The fundamental of this strategy was the application of science and technology for increasing yield per hectare. This strategy, known as New Agricultural Strategy or ‘Green Revolution’, was based on the extension of high yielding varieties responsive to heavy doses of fertilizers and the package of improved practices in selected areas with assured rainfall or irrigation facilities” (Tripathi et al., 2009: 64). After the introduction of green revolution technology, agricultural intensification or “increase in productivity replaced expansion as the main source of growth in agricultural production” (Tripathi et al., 2009: 64).

The introduction of the new technological package (improved HYV seeds, and synthetic fertilizers), which came to be known as the ‘green revolution’ was concentrated in India’s North Western State of Punjab. “Punjab, the "breadbasket" of India, was historically considered to be one of the most fertile areas on Earth, producing wheat, cotton, sugarcane and vegetables. Covering only 1.5% of India’s land, today the state produces nearly 20% of the nation’s wheat and 12% of its rice”(Colombia, 2014). In comparison to the rest of India, Punjab was uniquely positioned to absorb the new technology due to its existing irrigation network (its name means five rivers) and better than average infrastructure, developed during the colonial period. Despite it relatively high level of development Punjab was more affected by the upheavals and violence of partition than other parts of India. It is possible that Punjab’s history of violence increased its receptivity to green revolution technology. For a region where life had been marked by upheaval, the easy and rapid increase in production offered by the new technology was likely experienced as the beginning of a longed for period of peace and prosperity.

Nationally, the green revolution in India was essentially an economic development project aimed at alleviating rural poverty and famines and realizing *swadeshi* or self-reliance, in terms of food, “the second most important rallying cry of India’s freedom movement after *swaraj*, or self–rule” (Luce, 2007). The green revolution was wildly successful as improving productivity to staple food grains and the goal of national food-grain self-sufficiency was quickly met. “New policies and agricultural techniques were undertaken to accomplish these goals, but over time they began to have unintended ecological and social consequences” (Colombia, 2014).

The Green Revolution and its Repercussions:

As the food crisis of 1966 loomed, India was ready to make the transition to intensifying agriculture with the use of new technology. High yield, dwarf varieties of wheat and later rice, developed by American Biologist Norman Borlaug, had been brought to India by 1964.

By the mid-1960s, Indian agricultural policies were adjusted to utilize and promote the new seeds. The program concentrated on one tenth of the cultivable land, and initially on only one crop- wheat.

> By the summer of 1965, India with Pakistan, had ordered 600 tons of wheat seed from Mexico (where the new HYVs were being developed). In the fall of 1966, India

> spent $2.5 million for 18,000 tons of Mexican wheat seed. By 1968, nearly half the wheat planted came from Borlaug's dwarf varieties. By 1972/73, 16.8 million hectares were planted with dwarf wheat and 15.7 million hectares were planted with dwarf rice across the third world. 94% of the hybrid rice was in Asia, of which nearly half was in India.
>
> (Shiva, 2010: 54, 62)

The new 'High Yield Varieties' (HYVs) had very specific cultural needs compared to existing, traditional or indigenous plant varieties. They were dwarf varieties which were selected to respond to chemical inputs by producing high fruit to foliage ratios, thus preventing lodging (falling over- the response of traditional varieties to heavy inputs). Thus, the green revolution technology was a 'package' which included the new hybrid seeds and the chemical inputs necessary to achieve 'high yields'. These new seeds also required substantial irrigation, making them ill-suited for dry land cultivation or utilization on marginal farms. In the absence of irrigation and synthetic fertilizer the new HYVs were no more productive than indigenous varieties. "The term 'High Yielding Varieties' is a misnomer because it implies that the new seeds are high-yielding in and of themselves. The distinguishing feature of the seeds, however, is that they are highly responsive to certain key inputs such as fertilizers and irrigation. Dr. Palmer, of the United Nations Research Institute for Social Development, therefore suggested the term 'high-responsive varieties' (HRVs) to replace 'high yield varieties' (HYVs)" (Shiva, 2010: 72).

To facilitate the necessary investments on the part of farmers, for adopting the new technology package (hybrid seeds, synthetic fertilizers, and irrigation improvements), the government instituted subsidies for fertilizer and electricity (to run irrigation pumps) in addition to reducing credit rates and expanding credit services for farmers. To ensure stability of production the Agricultural Price Commission was created "with the objective to ensure remunerative prices (minimum support prices, MSPs) to producers" of the new crops. Other government support took the form of new "investment in research and extension services, and improving rural infrastructure" (Tripathi et al., 2009:2). Because of the dramatic yield increases and substantial government support, the adoption of the green revolution, which amounted to the industrialization of much of Indian agriculture, was rapid and widespread. In areas with ideal conditions, like Punjab, the adoption was near complete.

One school of thought holds that the modern agricultural science that issued in the green revolution has fundamentally improved plant breeding, paving the way for new technological innovations that will solve the problem of future food production. "Agricultural production and efficiency largely depend upon the inputs applied and the methods adopted. [The problem of food security can be tackled] by applying inputs in a more intensive way and by adopting modern methods of production through use of improved technology" (Tripathi et al, 2009:14). On the other side, critics of the green revolution argue that the gains may be great but that the negative consequences are greater, and that the re-percussions of the green revolution in India, and around the world will ultimately undermine the ability of new technologies to meet future food needs. The tradeoffs between extreme agricultural productivity and sustainability which emerged in the aftermath of the green revolution demonstrate how incompletely the question of 'how to feed a growing global population' has been answered.

While the sites of the green revolution, like Punjab, remain productive today, the dramatic yield increases initially experienced, are far less apparent. "Profitability in farming started falling from 1980/81" (Sidhu, 2005:199). "All crops except sugar showed declining trends between the initial years of the green revolution in the mid-1960s and the post WTO period beginning in 1996/97. This deceleration is very high in Cereals, Corse Cereals, Pulses, and Oilseeds with the growth rates turning negative in the case of pulses. The post WTO period (1996/97- 2006/07) showed the most dramatic declines in productivity recorded since reform with the growth rates in output of all crops decelerating from 2.93% to 1.57%; and livestock declining from 4.21% to 3.40% (Tripathi et al., 2009: 2-3). As yields stagnate, the cost of inputs continues to increase, threatening the economic viability of many farms. Increased use of inputs compromises ecological functioning, contributing to ever declining yields and ultimately threatening the gains made during agricultural reform and overall food and environmental security for the nation.

India's, declining agricultural output can be attributed to the breakdown of necessary agro-ecological processes which depend on diversity. "The production model which focused initially on the introduction of improved, higher-yielding varieties of wheat and rice in high potential areas relied upon and prompted homogeneity: genetically uniform varieties grown with high levels of complementary inputs, such as irrigation, fertilizers and pesticides, which often replaced natural capital (fertilizers replaced soil quality management, insecticides replaced crop rotation etc.)" (FAO, 2011b: 15). The gains of agricultural reform and the green revolution in India were achieved within a framework which aimed to control conditions through uniformity and unconstrained use of inputs. This approach "led to development and promotion of a narrow set of crops, breeds and management practices suited to high-input farming" (FAO, 2011a: 30). Destruction of agro-biodiversity and diversity of management practices in the wake of agricultural industrialization has been profound, resulting in simplified agro-ecosystems that are becoming increasingly incapable of supporting even low productivity.

Prior to the green revolution farmers used a much wider variety of seeds and techniques, growing many different crops, utilizing diverse cropping patterns and relying on system integration (green manuring, mixed legume rotation etc.) to achieve productivity. In pre-reform Punjab crops included 41 varieties of wheat, 37 varieties of rice, 4 varieties of maize, 3 of bajra, 16 of sugarcane, 19 varieties of pulses, 9 oil seeds and 10 varieties of cotton in addition to guavas, dates, mangoes, citrus, stone fruits, figs, pomegranates, mulberries, grapes, almonds, melons, apples, beans, cucumbers, carrots, turnips and 'minor cereals': millets, amaranths, and maize. Non-food crops included indigo, sugarcane, cotton, and hemp. The uncultivated areas were covered by date palm, wild-palm, willows, acacias, sisoo, and many others (Shiva, 2010: 84).

Before agricultural reform, rice was an insignificant crop in Punjab. "Since then, wheat and rice production has grown increasingly important, as Punjab became the primary source for government grain reserves" (Luce, 2007). Rice occupied only 6.8% of the gross cropped area in 1970/71 rising to 25% by 1990/91 and 33% 2000/01. From 1970/71 to 2000/01 the gross cropped area under rice and wheat together rose from around 48% to nearly 76%. The area under pulses like gram (which are an important source of protein in vegetarian diets and also a legume, fixing nitrogen and rebuilding soils) has declined sharply with nearly 360,000 hectares under cultivation in 1970/71 reduced to less than 10,000 in 2001. These statistics reveal a major shift, which took place at the time of agricultural reform (1960s & 70s) in the cropping pattern of Punjab, away from traditional, diverse and mixed cropping to industrialized monocultures of staple grains. In the wake of the green revolution wheat is planted in the rabi (spring) season, at the expense of gram, rapeseed and mustard. Rice, which is planted in the karif (autumn) season, comes at the expense of maize, groundnut and millets. Not only have "areas under legumes and foliage crops declined considerably, but areas under crops such as sugarcane, sunflower, potato, etc., have not remained stable and areas under cotton has been adversely affected due to water logging in the cotton belt and pest attack" (Sidhu, 2005: 201).

Simplification of traditional mixed cropping systems to monocultures, predominately of rice and wheat, has led to a number of well documented environmental problems including increased incidence of pests and disease in both crops and human populations. Simplification has also allowed for the easy mechanization of farming systems. This has had negative impacts on rural employment [7] and has greatly increased the energy intensiveness of agriculture and its overall environmental impact, including- for Punjab- severe declines in the water table. "Following the same model that had revolutionized manufacturing, agriculture adopted mechanization, standardization, the use of chemicals and other labor-saving technologies" (FAO, 2011b: 15). Growth in the number of tractors and irrigation pump sets illustrates the degree to which agriculture has become mechanized in intensive areas like Punjab. The number of tube wells and pump sets has increased from 19,200 in 1970-71 to 935,000 by 2000-01 and the number of tractors in the state has risen from just 30,000 in 1970-71 to more than 400,000 in 2000-01. Similarly the use of other inputs has also increased with NPK fertilizer use rising from 38 kg/ha in 1970/71 to 179 kg/ha in 2000/01 (Sidhu, 2005:198). The UN FAO attributes the successful increases in agricultural

[7] See 'Livelihoods & Labor' pg. 73

productivity experienced during and after the green revolution to "the use of heavy farm equipment and machinery powered by fossil fuel, intensive tillage, high-yielding crop varieties, irrigation, manufactured inputs and ever increasing capital intensity" (FAO, 2011b: 15).

The capital intensity of the green revolution package poses the problem of costs to farmers and governments. Substantial government support for green revolution technology and the 'miracle' productivity gains led to the declining viability of small farms and traditional farming methods. This rapid decline circumscribed the availability of farmer saved seed, further compromising traditional methods and contributing to the near complete adoption of the new technology, even on farms that were not well suited for it. Over time, waning government support and declining yields has led to increasing costs. The purchase of new seeds each planting cycle represented a new cost to farmers who had previously drawn this resource from outside of the market. The success of improved varieties depends on inputs of fertilizer and their extreme vulnerability to pests requires additional applications of pesticides, in addition to increased irrigation requirements and increased mechanization representing still more costs. Today the capital intensity of 'modern' farming (fertilizer, pesticide, machines and fuel) is becoming a serious problem, exposing both farmers and governments to significant financial risk. "If we also take into account small implements required in agricultural operations, the total present value of capital investments in farm machinery alone is estimated to be approximately Rs. 80billion (nearly $1.3 billion). These capital assets serve the requirements of the rice/ wheat cropping pattern and cannot be easily adapted to suit any other cropping pattern, discouraging diversification" (Sidhu, 2005:206).

Ultimately, capital intensive agricultural methods were widely adopted for the purpose of maximizing yield productivity of individual crops in the name of national food security. These methods are extremely effective for increasing single crop productivity (wheat and rice) but they ignore the multi-functional nature of agriculture itself. The selection of HYVs for their dwarf characteristics and fruit over foliage production illustrates how the multiple uses of crops have been removed from industrial food systems. Traditionally food systems delivered a wide variety of services, regulating, cultural and provisioning both of primary (rice) and secondary yields (paddy straw). Many of these functions, which cannot be easily managed (through mechanization for example) or quantified for the market (environmental and cultural services), are disregarded in industrial food systems. The extreme focus on single crop productivity has served to disproportionately disadvantage the poorest segments of the population who, living largely outside of the market, have traditionally depended on 'free' agro-ecosystem services and secondary functions of agricultural yields (paddy straw for animal fodder, cow dung for cooking fuel, manure for maintaining soil productivity).

The case or paddy straw (the stalks and foliage of rice plants) in Punjab makes clear, the disregard for multiplicity of uses, inherent in modern agriculture. On traditional or integrated farms, paddy straw is utilized in many ways: as construction material, animal fodder, and/or soil amendment. On industrial farms paddy straw is viewed as a worthless crop residue and is typically burned causing serious pollution problems and leaching soil nutrients. The situation has become so extreme that at the time of this research, in September 2013, Punjab Agricultural University (PAU) held its bi-annual farmers fair (*Kisan Mela*) under the theme 'do not burn paddy straw'. In the Ludhiana district of Punjab, surrounding

PAU, air pollution from the burning of paddy straw during the rice harvest season is so severe that residents are advised to stay inside earning Ludhiana the dubious title of 4th worst city in the world in terms of air pollution (India TV, 2013).

According to the United Nations: “agricultural intensification in the 20th century represented a paradigm shift from traditional farming systems based largely on the management of natural resources and ecosystem services, to the application of biochemistry and engineering to crop production” (FAO, 2011b: 15). While the gains from the New Agricultural Policy in India have been spectacular, today the resulting problems are becoming harder to ignore. The obvious benefits have been the achievement of Indian food grain self-sufficiency, increased food security and development via modernization. “The green revolution is credited, especially in Asia, with having jump-started economies, alleviated rural poverty, saved large areas of fragile land from conversion to extensive farming, and helped to avoid the Malthusian outcome of growth in world population” (FAO, 2011b:15). The costs have been monetary, environmental and cultural, and these costs are increasing with time leading to dependence for farmers and vulnerability for governments. These serious tradeoffs bring in to question the ‘miraculous’ achievements of agricultural industrialization and green revolution technology. I asked one Punjabi historian and ancestral farmer if he thought that the green revolution was a miracle. His response was “Yes, it was certainly a miracle but its miraculous character was quickly forgotten” (Mann, Conversational Interview, 3/14). In the words of green revolution critic Vandana Shiva: “One way in which agricultural research went wrong was precisely in saying, and allowing it to be said, that some miracle was being produced. Science and technology made their first advances by rejecting the idea of miracles in the natural world. Perhaps it would be best to return to that position" (Shiva, 2010: 46).

Today the United Nations calls for 'greening' the green revolution through ecosystem approaches which draw on nature's contributions to crop growth, such as soil organic matter, water flow regulation, pollination and bio-control of insect pests and diseases. Due to the declining yields and rising costs of conventional agriculture, it is unlikely that these methods will achieve the sustainable intensification of agriculture necessary to ensure global food security, or that new technology will be developed that will solve the diverse problems (displacement of labor, reduced ecosystem functioning) that stem from the widespread industrialization of food. In order to meet sustainable development goals related to poverty, food security and environmental sustainability new food production methods which make pragmatic use of *all* available models particularly 'free' ecological functioning and system integration will be necessary.

People, Livelihoods and Cultures

Food systems link directly to issues of poverty and hunger through livelihoods, labor and the ways in which people provide for themselves and their families. In rural areas where agriculture is the main industry, the structure of agricultural systems fundamentally shapes the daily lives and livelihoods of people.

Of India's 1.2 billion people, 3 out of 4 live in rural areas. This is true for 77% of India's poor as well. At least 50% of the workforce is engaged in agriculture directly or indirectly (World Bank, 2014c). At a global level, the UN FAO reports that "small farmers and their families make up more than one third of the total population, and over half of the world's rural poor" (FAO, 2011b:22, FAO, 2014). Rural agro-ecosystems emerge as critically important to the livelihoods of huge segments of the global population. In India this is overwhelmingly true for the poor with 240million poor people living in rural areas contrasted with 72 million in cities (World Bank, 2014c). Given these statistics it is clear that the livelihoods of famers in rural areas have tremendous bearing on all poverty alleviation efforts and on global food security with "small farmers producing about four-fifths of food supplies in developing countries" (FAO, 2014).

Livelihoods and Labor:

> Few of the farmer's children will be able to afford to stay on the farm- perhaps even fewer will wish to do so, for it will cost too much, requires too much work and worry, and it is hardly a fashionable ambition.
>
> (Berry, 1996:41)

Development and agricultural industrialization has had profound effects on the roles of people in food systems throughout the world. A shift towards monocultures which has resulted in simplification and mechanization has greatly reduced the need for human knowledge and labor in production and processing, leaving little room for human participation in agriculture and "seriously affecting agriculture's capacity to absorb labor over time". H.S. Sidhu of Guru Nanak Dev University in Amritsar, Punjab explains: "The employment elasticity with respect to aggregate agricultural output in Punjab has already turned negative. In the case of wheat, per hectare use of labor was 680.27 man hours/hectare in 1975/76. Thereafter it started declining almost continuously and finally stood at 301.15 man hours/hectare in 1999/2000. Similarly, in the case of paddy the labor use per hectare was 961.44 man-hours in 1974/75. In 1998/99 it stood at 450.54 man hours/hectare" (Sidhu, 2005: 205-206).

These figures show that labor demand, as measured in man hours, had dropped by more than half in the decades following agricultural industrialization in Punjab. This has meant that huge sections of the labor force, particularly landless laborers and small, poor and/or marginal farmers unable to meet the scale and capital requirements of industrial agriculture have been pushed out of the rural labor force. There is doubt over whether the still young modern sector the Indian economy can accommodate the monumental influx of labor, particularly young people who leave the farm to pursue education. "Whether Punjab's small and medium scale industries will be able to absorb this massive shift of labor force, which has gone away from agriculture, is doubtful. Already there is a huge army of unemployed in the state and most of them are educated unemployed" (Sidhu, 2005: 205-206).

India's green revolution is illustrative of prevailing trends in modern agriculture, which tend toward eliminating labor in food systems. This trend displaces rural labor, exacerbating unemployment and inequality in rural areas but also breaking the connections between people and places and resulting in widespread migration. This has been especially injurious to communities in which labor is abundant and capital is scarce, which is the case for most rural areas in India and the developing world a whole. In these areas, the adoption of labor minimizing, capital intensive agricultural systems is especially threatening to rural livelihoods since agricultural jobs are generally held by a segment of the society who often does not possess the skills necessary to easily transition into other sectors of the economy. Even when education and skills are obtained, the developing modern sector does not necessarily provide the opportunities necessary to facilitate such a transition. In Gandhi's words: "Mechanization is good when hands are too few for the work intended to be accomplished. It is an evil when there are more hands than required for the work as is the case in India" (Gandhi 1959 in Shiva, 2010:238).

In spite of economic growth on a large scale via industrialization in agriculture and other sectors, poverty and food insecurity remain consistent problems, particularly in rural areas. According to the UN FAO, one reason that economic growth has failed to benefit poor people is because it has occurred, in sectors that do not create employment for the poor (technology, service, finance) or, in ways that reduce employment opportunities for poor people in the traditional economic sectors, like agriculture. "To reduce poverty and hunger growth should generate demand for those assets controlled by the poor. In all cases the poor own their own labor and sometimes that is all that they own" (FAO, 2012: 22, 31). It is argued that growth in low skilled, labor intensive industries, specifically agriculture, "more so than in other sectors can generate economic benefits that deliver benefits to the poor" (FAO, 2012: 6).

Advances in agricultural productivity via industrialization have also served to disadvantage small, poor and/ or marginal farmers. With the industrialization of agriculture, farms unable to make the large capital investments necessary to achieve productivity, experience rapidly declining yields and are often forced out of business or into debt, exacerbating the issues of rural poverty and unemployment. Over time farms have become smaller (divided over generations) or bigger (consolidated and modernized). Large farms have maintained profitability by achieving economies scale whereas small farms, ill-suited to industrialized farming are disappearing. In India, population density, and land ownership caps have meant that, divided over generations, farms are no longer of sufficient size to support a family and most young people will leave the farm to seek education and employment elsewhere.

As the process of industrialization divides farms into those who are large, mechanized and successful and those who are small, manual and poor, views on labor intensity in farming systems also change. In industrial systems poor farmers are very often those who do not have the capital to mechanize and so must operate with greater dependency on human and animal labor. In this way the work of farming becomes debased and increasingly comes to be seen as 'backwards' or 'low class'. "The growth of industrial agriculture has been accompanied by the growth of the idea that work is beneath human dignity, particularly any form of hand work. We have made it our overriding ambition to escape work, and as a consequence have debased work until it is only fit to escape from" (Berry, 1996:12). The elimination of labor from agriculture has increased profits in the short term for those farms that can afford mechanization. However, it has also reduced the opportunities for human contributions to food systems through labor, design and innovation, that are needed to achieve poverty alleviation and ensure functioning and profitability in the long term.

Integrated food systems, are well suited to use on small farms, utilizing many of the practices that have historically made small scale subsistence agriculture possible. In these systems production of what the UN FAO has termed 'high value crops' is quite feasible. High value crops include vegetables, fruits and animal products like dairy. These products are high value “both nutritionally and in terms of income” (FAO, 2012: 6). High value crops require more human labor and attention than do grains, and are less amenable to mechanization making them ideal for small and marginal farmers and for production in integrated systems.

Although diversification of food production, potentially through the use of IFS to produce ‘high value’ products emerges as a clear path towards addressing many of the problems that have resulted from agricultural industrialization, including rural poverty and unemployment. One obstacle comes up: in poverty stricken areas where promotion of this type of production is likely to be most effective, finding markets for high value, specialty or niche products can prove exceedingly difficult for farmers. With the proper conditions in place (favorable policies, infrastructure, accessible markets) adoption of labor intensive, ‘high value’ products via IFS is likely to provide new opportunities for rural employment and poverty eradication.[8]

Adoption of more labor intensive practices, such as farm system integration, can ultimately reduce the cost of farming. As fuel prices rise and the inputs necessary to sustain monocultural productivity become more expensive, industrial agriculture becomes increasingly problematic. Decreasing availability and rising prices of energy in the future mean that more integrated and diverse farming practices will have to develop, drawing energy from human labor and natural processes instead of fossil fuels, mechanization and petroleum based chemical inputs. In developing countries with abundant labor forces and limited capital, the transition from capital intensive agriculture to labor intensive agriculture will likely be less costly than continued increases in energy intensity.

[8] See ‘Food & Agricultural Policy’ pg.93

Integrated food systems clearly have the potential to contribute to poverty reduction through the creation of greater employment opportunities on farms. In addition, IFS have the economic benefit of diversification- allowing for the production of multiple crops, year-round production (and employment), and promoting the production of ‘high value’ crops. The economic gains of the green revolution are inseparable from the social costs in the form of lost livelihoods and traditions. Waning economic gains from industrialization call for a re-examination of these trade-offs. If the displacement of labor from traditional rural economies as a result of the industrialization of agriculture is a contributing factor to rural unemployment and related issues like poverty and food in security, then it follows that the adoption of more labor intensive agricultural methods, like IFS, which require progressively less capital may be able to alleviate some of these problems.

Debt:

Capital intensive agriculture has resulted in increasing incidences of debt among farmers, exacerbating poverty and insecurity. Because of the ‘miraculous’ gains in productivity experienced at the beginning of the green revolution, and because of the huge outlays of government support in the form of credit for the green revolution package of purchased seeds and inputs, agricultural industrialization was initially experienced as extremely profitable and as such extremely enticing to nearly all farmers. The promise of the package persuaded many small and marginal farmers whose lands many not have been well suited for the new farming methods.

Over the years as government support has waned, and productivity has declined the costs of inputs has increased. “The high subsidies and support prices of the early years could not be maintained indefinitely” (Shiva, 2010: 179). In this way the initial profitability of the green revolution has been transformed into a debt burden for farmers. Many farmers now depend on credit to obtain the necessary capital to finance the continued use of green revolution technology. It goes without saying that high levels of debt have negative bearing on issues of poverty, livelihood and wellbeing. Debt has even been credited with the rash of farmer suicides taking place in many agriculturally intensive areas throughout India, but that is a topic for a different study.

Credit was, and continues to be, provided for farmers by both state and federal governments. Nonetheless farmers often access credit though the large networks of private and informal money lenders and commission agents. These types of private loans are appealing, particularly to poor and uneducated farmers, because they are provided more quickly and without the bureaucratic process required to access government loans. However, private and informal loans often carry much higher interest rates, and so greatly contribute farmer indebtedness and cycles of poverty in agricultural areas.

Within the context of conventional agriculture, it is extremely unlikely that the cost of inputs will decrease in the face of declining environmental conditions and ever increasing demand. Growing costs may make this method of farming impossibly costly for both producers and governments in the near future. The growing debt in agricultural communities is further evidence of the fundamental unsustainability of conventional agriculture. If economic and social sustainability is to be prioritized then alternative methodologies like integration must be developed and implemented.

The Commercialization of Food Systems:

> The progressive farmer of Today became the farmer who could most rapidly forget the ways of the soil and learn the ways of the market.
>
> (Shiva, 2010: 191)

More than forty years after the green revolution, Indian agriculture continues to straddle the divide between ‘traditional’ and ‘modern’. Through the course of its transition economically viable ‘traditional’ farms are disappearing in India. Industrialization of food systems has contributed to conceptions of ‘right livelihoods’ and ‘the good life’ that are tilting in favor of growth, modernization, and consumer culture- worldwide. This has meant that the role of the farmer in farming has also changed. In the context of industrialized commercial agriculture, the farmer can no longer be purely a producer. In order to be successful, to escape debt and turn a profit, today’s farmer must also be an ‘agro-businessman’.

The green revolution has marked this turning point for many areas of India, bringing increased commercialization and commodification of food and agriculture. Prior to the green revolution, it would seem that most farmers saw themselves primarily as producers: meeting family food needs through the farm. Traditionally, the role of farmer as businessman was secondary: selling small surpluses for extra cash in order to supplement the household with goods not produced on the farm. With the dramatic increases in yields achieved during the 1960s and 70s farmers, specifically in agriculturally intensive areas like Punjab, shifted their focus to monoculture production of staple grains.

Large crops of grain were intended for sale in the market and not for home consumption. With more farms geared towards production for markets and away from household subsistence, basic needs- food, energy, tools etc. became increasingly mediated by the market as well. Dependence on the market meant a decline in farm self-sufficiency and a shift away from "the old ideal that a farm should aim at economic independence; that is it should be far more productive than consumptive, more a source than a consumer of material goods" (Berry, 1996: 37). Participation in the growing agricultural market demands from farmers, a new knowledge and skillset- one of commerce and specialization, not necessary in pre-industrial times.

In subsistence agriculture "diversity of crops is essential to provide nutrition, variety and regular supply. Thus self-reliance demands diversity" (Holmgren, 2009: 207). The re-distribution of food through markets allowed for the specialization and marketable yield increases of monoculture productivity. With diversity on the farm replaced by diversity in the market place, traditional cultures of self-reliance based on diversity break down. "The community disintegrates because it loses the necessary understandings, forms, and enactments of the relations among materials and processes" (Berry, 1996: 21, 45). Commercialization of agriculture, contributes to the loss of traditional cultures, place based knowledge systems and the household skills of self-reliance which have historically been livelihood staples for the poor.

With household food needs now met through the market, and new generations alienated from the traditional 'skills of poverty', declining yields and rising input costs pose a serious threat to food security for agricultural households. When farmers become indebted and cash poor, their ability to access nutritious food and other basic necessities may become severely compromised. For Holmgren: “no one is as disadvantaged as the poor without the skills of poverty, basic household skills” (Holmgren, 2009: 62). With over 50% of the Indian workforce engaged in some form of agriculture and 77% of poor people in rural areas (The World Bank, 2014c) , loss of these skills of self-reliance has had cascading negative effects on environmental degradation and cycles of poverty.

Punjabi Historian G.S. Mann describes “a chasm between the mentality of the farmer as producer and the farmer as ago-businessman” (Mann, Conversational Interview, 3/14). Wendell Berry offers a complimentary observation: “The commercialization of agriculture is a matter of complex significance, and its agricultural significance cannot be disentangled form its cultural significance. It forces a profound revolution in the farmer’s mind: he must forsake the values of husbandry and assume those of finance and technology” (Berry, 1996: 45). Such a profound divergence in perspectives suggests that, the framework through which a farmer approaches production (as sustenance or as money), has implications for how that food is perceived, food systems are structured and how agro-ecosystems are maintained.

Food production for profit as opposed to sustenance means the imposition of different standards for success for food systems (single crop productivity vs. overall system productivity) and new definitions of skills and knowledge for farmers (management of machines and marketing prowess vs. management of complexity and quality of workmanship). Berry explains:

> The work and skills of farming once included standards of quality and good care but have “come more and more under standards that are merely economic or quantitative. The consumer wants food to be as cheap as possible. The producer

> wants it to be as expensive as possible. Both want it to involve as little labor as possible. And so the standards of cheapness and convenience, which are irresistibly simplifying, have been substituted for the standards of health (of both people and land), which would enforce consideration of essential complexities.
>
> (Berry, 1996:92)

Social & Cultural Values:

> The majority of people on the planet still have some personal or family experience of a culture of place and living from renewable local resources. Most of these people are struggling to climb aboard the train of industrial affluence. In the process monetary incomes rise, but the people lose access to unmeasured wealth and have to discard their most useful technical skills and social values.
>
> (Holmgren, 2009: 121-122)

Mumbai based Journalist Aparma Pallavi has studied and written on the food traditions of India for more than 20 years. Her work deals with nutrition security in agricultural households and the ways in which nutrition is shaped by local food traditions, drawing interesting connections between health, quality of life and relationships to food. She looks at all types of farms from ‘primitive’ and tribal to large-scale and industrial, analyzing how household nutrition relates to degrees of on-farm industrialization.

Pallavi identifies three categories of agricultural household: Tribal, Rural/ Semi Industrial, and Fully Industrialized/ Commercialized. She finds that “the more industrialized the farm, the poorer the nutrition profile of the farmer and his family" (Pallavi, Group Interview, 8/27/13). She concludes that Tribal people who typically depend for their sustenance on equal parts agriculture and hunting and gathering, and who are technically the poorest, living essentially outside of the market, also have the most diverse diets and as such, best nutrition profiles. On the other end of the spectrum are the Fully Industrialized or Commercialized Farming households, where crops are gown exclusively for the market. These homes are often quite well off but nonetheless, Pallavi finds that, of the three groups, they have the poorest nutrition profile- the least diverse diets, consuming predominately processed and packaged food and very few vegetables. In the middle, with declining nutrition profiles, diets in which diversity is disappearing, are those Rural/ Semi industrial households who struggle to reap the benefits of industrial farming and who are often indebted and squeezed by urgent pressures, meaning that available cash is often channeled away from nutrition and towards other household necessities (education, health care, etc.).

Pallavi's work highlights the potential effects of cultural changes on food related development goals like food and nutrition security. She illustrates how the nutrition profiles of farming households are reflective of the food systems in which they work and are embedded. She finds that those people (Tribal) who are the most connected to their traditions tend to have superior nutrition whereas those who are least connected (Industrialized) or who are in the process of losing those connections (Semi-industrialized) have the least nutritious and also least enjoyable food. The issue of enjoyment is an important one for Pallavi as her work also highlights the ways in which interactions with and understandings of food effect quality of life and feelings of satisfaction and happiness. Her work seeks to capture the intangible values provided by food systems. She explains that part of what is lacking from the diets of industrialized people is a lack of ‘sustenance for the soul’ and for ‘universal connection’ (Pallavi, Group Interview, 8/27/13).

Pallavi’s work suggests that many of the discrepancies between food security (in terms of quantity of food) and nutrition security (in terms of quality of food), particularly in affluent households has to do with cultural understandings and perceptions of ‘good food’. She finds, for example, that tribal people have better nutrition profiles not only because they have access to greater diversity of food but also because that food is understood differently than in industrialized households. Tribal people understand the nutritional value of diversity because of the fleeting availability of crops in natural systems. “In tribal areas people simply have to eat what is grown in a specific season. There is an understanding that food is a shifting thing and that one must east what is available *now* because in 15 days it will no longer be available and that specific nutrition profile will be lost” (Pallavi, Group Interview, 8/27/13).

It is believed that through the gradual process of industrialization, people have become, or been made to feel, ashamed of their local food traditions. For example, Tribal People- who in Pallavi’s view- have the best food, are viewed as ‘primitive’ and ‘backwards’ by mainstream Indian society. Because of social stigma many food traditions (such as how to access nutritious wild plants), are lost or are unused by people who could benefit from them. For ecologist David Holmgren, these negative associations often stem from a “perception that the rest of the world is affluent and uses modern methods.” (Holmgren, 2009: 122).

The social perception of coarse grains, like brown rice, is another example of the denigration of traditional foods that could be nutritionally and economically useful, particularly for the poor. “Because processed food is associated with wealth, poorer people (who traditionally have better, more nutritious food) have become ashamed of and have lost respect for their food traditions” (Pallavi, Group Interview, 8/27/13). In India, as in many parts of the world, traditional foods like coarse grains (brown rice) have come to be considered ‘poor food’. Ironically, their superior nutritional value has led to their emergence as fad health and diet foods in the west where they are sold for 500 times the price at which they are sold in India (Pallavi, Group Interview, 8/27/13). The mentality that sees traditional coarse grains as ‘backwards’ or ‘low class’ leads to missed opportunities for Indian producers and consumers economically, socially, and environmentally. Negative social perceptions appear to be key factors in constraining the wider production of more diverse, nutritious foods.

Changing attitudes about ‘good food’ and the rejection of food traditions in favor of status symbol foods (like fast foods, packaged or processed foods, and white rice) can be understood as an outgrowth of the process of ‘cultural succession’. Just as succession occurs in ecosystems, changing their structure over time it also occurs in societies, communities and families. The typical story of development is one of ‘progress’- that is, progress from a modest rural beginning connected to place, to migrants, urban workers, to small businesspeople, and eventually to educated professionals and urban affluence. “This pattern can be seen in all cultures and is now a truly global social process. This successional pattern, and variations on it, has been repeated in the histories of hundreds of millions of families worldwide over the last century” (Holmgren, 1996: 256).

According to Pallavi, in India, changes in nutritional profiles (away from diverse, traditional foods) are largely driven by the young people who go outside of the village to become educated. Through ‘education’ they gain a negative attitude about their own food traditions, for example rejecting meat in favor of the vegetarian mainstream, or rejecting vegetarian values for fast food culture based around meat consumption. Once the children go into the education system and move toward urbanized aspirations, the family food profile changes drastically. An anecdote illustrates how cultural succession results in the loss of diverse, local food cultures:

> At one government school for tribal children, the children were catching crabs and bringing them to school. They would first play with, and torture the crabs and eventually, cook and eat them. The teacher, a Hindu woman from the city, was horrified and scolded the children. In fact the only problem was the play and torture of the animals. Crabs are extremely nutritious and the children are in fact, at a nutritional advantage for the knowledge of how to catch, cook and eat them. The response of the school should not be to discourage the catching and eating of crabs but only the torture of animals. This is a perfect example of how healthy, local food traditions are being shamed and discouraged in mainstream Indian society. Such traditions are not environmentally invasive, are more nutritious, and are not based on cash and market participation and so are accessible to even the most destitute. (Pallavi, Group Interview, 8/27/13)

‘Cultures of Place’ which are shaped by the unique interactions between landscapes, cultures, history and individuals have in turn shaped local food traditions throughout the world. The processes of agricultural industrialization and the accompanying cultural succession have, over time, replaced many of the world's diverse, place-based food and farming traditions with systems of standardization and universal methodology (markets and technology) applied across all contexts. Traditional cultures of place are part of what the United Nations has termed 'bio-cultural diversity', the human component of diversity in natural systems (FAO, 2011a:30). For the UN recognizing the links between culture and diversity in food systems will be critical to achieving food security and environmental sustainability in the future. "The role of biodiversity for food and agriculture is seen as fundamental: diversity is recognized as the basis for local, possibly forgotten specialties and sustainable food systems that bear a strong connection to cultural diversity" (FAO, 2011a:28). Following Pallavi, cultural diversity leads to diversity in food systems, and relationships to place, cultural values and perceptions of food provide the foundations on which food systems are structured. When these connections are lost or destroyed part of the fundamental value, the social and cultural value, of food is lost.

Intangible Values:

> The energy that is made available to us by living things is conceivable not so much to the analytic intelligence, to which it may always remain, in part, mysterious, as to the imagination, by which we perceive, value, and imitate order beyond our understanding.
>
> (Berry, 1996: 85, 138)

Measures of Human Development have recently sought to capture aspects of personal wellbeing as development indicators (Human Development and Gross National

Happiness indexes). This effort implies acknowledgement, on the part of major international development actors, that human experiences of wellbeing, in a general and subjective sense, must have some bearing on understandings of sustainable development. When evaluating outcomes and setting development goals, the less tangible aspects of human wellbeing- food quality (nutrition) in addition to quantity (food security), and spiritual and aesthetic values as well as economic ones- must also be considered.

By the United Nations definition of 'bio-cultural' diversity, human cultures and cultural landscapes, like ecosystems have the capacity to generate 'services'. These services include the aesthetic, spiritual and recreational values of landscapes and cultures of place. "The benefits obtained from these intangible services contribute to various aspects of human well-being, such as adequate livelihoods, sufficient nutritious food, health, secure resource access and security from disasters" (UNEP, 2011: 7). Neglecting these values in consideration of food and agriculture for development fails to fully capture what food systems *are* for people. Perhaps the difficulty of identifying and articulating these values and services, and the subjectivity of their nature, have contributed their long omission from formal development discussions and planning. The 'intangible values' of food systems represent a critical aspect of food and agriculture for development that is widely overlooked, limiting the potential of agro-ecosystems to fully deliver regulating, provisioning and cultural services.

In most food systems provisioning ecosystem services such as food, water, and timber production are disproportionately valued by humans compared to 'regulation' services (water filtration, provision of oxygen), and 'cultural' or 'intangible' services (aesthetic beauty, spiritual significance).The UNEP states that, "ecosystem services are not independent of one another: individual ecosystem services should be regarded as various elements of an interrelated whole. Efforts to optimize a single ecosystem service often lead to negative changes in others" (UNEP, 2011:9). Because "the quantity of provisioning ecosystem services used by humans increased rapidly during the second half of the 20th century, and continues to grow" (UNEP, 2011: 9), it follows that negative changes are being experienced in other ecosystem services. The evidence for this is clear: regulating services that ensure soil fertility and pest control for example, are breaking down in response to heavy chemical inputs and other intangible benefits are lost when people are displaced from their traditional lands and livelihoods, or landscapes are altered or destroyed because of industrialization. Industrial agriculture has been, essentially, a monumental attempt to increase the provisioning services of agro-ecosystems. The success of this attempt is indisputable and food and other provisioning services have increased dramatically over the last fifty years but this success has come at the expense of a complex network of other ecosystem services of all types.

While regulating, and cultural services are disproportionately undervalued in contemporary industrial or commercial agriculture, they are often well represented and more fully utilized in traditional agricultural systems. "Agricultural systems that are reliant on biological processes and on the natural properties of agro-ecosystems to provide provisioning, regulating, supporting and cultural services exist around the world. These are the characteristics of most traditional production systems" (FAO, 2011a:29). For example, in India traditional farming was done with a bullock cart. The use of animals on the farm provides all three type of services: The bullock plough the fields ensuring the provisioning services of food in addition the cows (also kept) provide milk (provisioning), the manure from the bullock enriches the soils as they plough, ensuring nutrient cycling and continued soil productivity (regulating), and the cow is considered holy by the farmer and his family, and by proper husbandry and care connects the family to divinity thought interaction with their agro-ecosystem(cultural). When traditional farming systems of this type are replaced by industrial farms, the cow/ bullock is removed and replaced by monocultures of wheat and rice, for example. All that is left, in this case, is the provisioning service of the rice/wheat, all of the other services have been eliminated from the system.

The relevance of food is common to all human cultures. Oliville, coins the term “gastro-semantics” to get at the web of dense meaning that connects food to culture. Berry asks his readers to “to consider the associations that have, since ancient times clustered around the idea of food – associations of mutual care, generosity, neighborliness, festivity, communal joy, religious ceremony” (Berry, 1996: 9). Food is, for example, central to diverse Indian spiritual and cultural practices. For Hindus food it is one of the four things shared by animate beings (food, sex, fear and sleep). In the Rig-Veda, food and eating are used to classify all reality (everything is either eater or eaten) and in the Upanishads, a person’s distance from food is seen as the yardstick of his holiness. In his examination of ethnographies of food in India, Oliville concludes that “the ritual, social, economic, nutritional, and medical aspects of food are intertwined and inseparable” (Olivelle et al., 1995). For Berry, food is a cultural product. “Those agriculturalists who think of the problems of food production solely in terms of technological innovation are oversimplifying both the practicalities of production and the network of meanings and values necessary to define nurture, and preserve the practical motivations” (Berry, 1996: 45).

Apart from their spiritual values and direct cultural linkages, food systems are part our aesthetic understandings of places. Positive aesthetics- art, beauty, architecture, design- provide benefits to people both in wild nature and the built environment. The aesthetic quality of a place contributes to the daily, personal wellbeing of the people who are there. “A positive view of the ecological role of aesthetics suggests that it represents the distillation of the essence or truths of design culture in forms that have a sensory and inner or spiritual resonance” (Holmgren, 2009:152). The ‘bioregional aesthetics’ of a place (its buildings, its landscapes) are part of what shapes cultural identity and are, in turn shaped by cultures. It follows that when place based aesthetics are disrupted by, for example, the industrialization of agriculture, so too are the cultures for which they are foundational. One could conclude that the most successful development, development aimed at human wellbeing, must also seek to preserve the aesthetics of place through the proper design of human systems, taking cues from existing place based systems and design successes. The aesthetics of farms and ago-ecological landscapes are as foundational to people’s lived experience as the design and aesthetics of cities and buildings.

It would seem that the loss of intangible values from ecosystems and food systems has been one of the less noticed side effects of agricultural industrialization. This process has clearly resulted in the loss and marginalization of many place based food traditions and traditional knowledge systems around food. This effect is in-line with agricultural development, viewed as process of transition from ‘traditional’ to ‘modern’ food systems but appears to ignore a number of important indicators of development. Many ancient food traditions represent models for sustainable production that have tremendous potential to be adapted and unscaled to meet contemporary needs in new ways. It is possible that in the coming decades marginalized cultures and food systems will provide the best source of new ideas for food, agriculture, and development, including with them- greater attention to the interconnectedness of people, food, nature and well-being at all levels.

For activists and development partners- truly sustainable development, that reduces poverty and hunger while ensuring environmental sustainability, must also provide jobs and opportunities for satisfactory livelihood. It must ensure nutrition security (quality of food) as well as food security (quantity of food), it must encourage stewardship of and investment in agro-ecosystems, and it must maintain the 'intangible' values of places and landscapes. It is widely held that successful development approaches must be participatory; engaging with the real needs of local communities, building on place-based, traditional knowledge systems and, particularly in the case of agricultural systems, must be properly designed to fit the specific site and context. Necessary policy frameworks that ensure food security while enabling, protecting and building on local traditions, and the full provision of cultural and other ecosystem services, as well as allowing for subjective conceptions of wellbeing across a multitude of contexts, will be extremely complicated to construct. In the next section the discussion turns more totally to policy, specifically: how can IFS be better incentivized via policy instruments? Which policies are currently discouraging to IFS, accounting for their limited adoption in spite of their significant benefits? and Which existing policy models may be utilized to incentivize IFS in India, and around the world?

FOOD & AGRICULTURAL POLICY

Because food and agriculture play such a central role in the lives and well-being of all people, the ways that agricultural systems are structured and the policies that support this structure are of utmost concern for questions of sustainable development. Food and agriculture are directly linked to some of the most fundamental challenges facing societies today: food and nutrition security, climate change, ecosystem stability, preservation of biodiversity, economic growth, rural livelihoods, and maintenance of landscapes and cultures. The future of global food security and environmental sustainability is deeply underpinned by the way that governments support (or do not) agriculture and food production through policy measures. "Agricultural policies drive production through the support they provide to certain sectors and in so doing they impact consumption through their action on supply" (Esnouf et al, 2013: 43).

India's singular policy focus on national food security through the production and distribution of staple food grains has dramatically improved food security for many but has resulted in numerous human and environmental health problems (discussed at length above[9]) and has created tension between the divergent interests of local, national and global governments. Within India national food security policies can conflict with state interests. For example, Punjab- now suffering from severe negative externalities associated with industrial production of grain- would prefer to diversify its agricultural sector however national price support policies have the effect of undermining these efforts (Johl, Formal Interview 9/28/13).

[9] See 'Why Change? Conventional Agriculture' pg.28

At the global level, agricultural support policies remain at the center of trade talks and protectionist disputes within the WTO, exacerbating tensions between the global 'North' and 'South'. At the December 2013 conclusion of the Doha round of trade talks, India was the locus of these disputes. According to the Hindustan Times "New Delhi's insistence that it be allowed to stockpile and subsidize grain for its millions of hungry poor emerged as a major stumbling block at the WTO conference of trade ministers in Bali" (Hindustan Times, 12/07/13). India's successful defense of agricultural support in Bali was lauded as "a triumph for millions of subsistence farmers throughout the world" (Indian Commerce and Industry Minister Anand Sharman quoted in Hindustan Times, 12/08/13). The accord also, solidified India's emergence as a major geopolitical power in the world sphere, lending new urgency and import to the structure of its food systems and the policy instruments that shape them. In India emphasis on national food security and food grain self-sufficiency via agricultural price supports does, when effectively managed, provide some benefits to its poor agriculturalists, however, it is the position of this researcher that the negative repercussion of such a system will circumscribe its benefits in the long term.

Greater levels of integration on farms, via agricultural diversification could potentially serve economic, environmental and food security needs in India very well, particularly in agriculturally intensive Indian sates like Punjab, where the negative impacts of conventional, monoculture farming are most acute. However, national policies aimed at shoring up food security and grain self-sufficiency via large scale production and distribution of staple grains, serve to discourage diversification. This is especially problematic in areas where diversification it is most needed, where the declining rates of return on farming most severe; states like Punjab.

India is a rapidly developing country who's poor and vulnerable population consists overwhelmingly of rural agriculturalists. 72% of India's 1.1 billion people live in rural areas. Many are poor and most depend on agriculture and/or wild forests for survival (The World Bank Group, 2011). In these circumstances, the structure of India's agricultural policies has tremendous influence over its development prospects. According to the World Bank "the Government of India places high priority on reducing poverty by raising agricultural productivity. However, bold action from policymakers will be required to shift away from the existing subsidy-based regime that is no longer sustainable, to build a solid foundation for a highly productive, and diversified agricultural sector" (The World Bank Group, 2011).

In order to meet its development goals of reducing poverty and hunger, improving health, and achieving environmental sustainability India will have to make major amendments to its current agricultural policy. In seeking to do this, Indian policy makers may look to the European Commission's Common Agricultural Policy (CAP). The evolution of Europe's agricultural policy is relevant for India because, like India, European agricultural policy one demonstrated a singular focus on food security by way of price support for agricultural products and inputs. These policies resulted in a number of unintended side effects which India experiences today, including unmanageable surpluses and environmental degradation. In response to these problems the European Commission's CAP has, over time, transitioned from a system of price support mechanisms for agricultural products to a system of wealth transfer through direct income support payments for farmers who meet specific conditionalities.

Europe is a unique case in that, other large, industrialized nations like the US employ agricultural policies similar to India's- providing support prices for priority crops (USDA, 2014), with similar unintended results- surpluses, environmental degradation, and displacement of labor. In contrast a system of direct payments, like the one established in the CAP, has the benefit of flexibility. Through direct payment systems, governments are able to target multiple objectives (food security, environmental sustainability etc.) by linking support not to production, but to specific objectives, for example- preservation of wild spaces, diversification of crops, or production of indigenous varieties.

Integrated food systems have the potential to address sustainable development goals in India. In order to incentivize their implementation a restructuring of agricultural policy in favor a system of direct, income support payments to farmers would be prudent. Since Europe has successfully undergone the transition from a system of price supports for agricultural goods to a system of direct payments to farmers, its approaches to agricultural support may provide a working example for Indian policy makers as they seek to sustainably intensify agriculture in the coming decades.

Indian Agricultural Policy

Since India's 'New Agricultural Policy' was instituted at the time of the green revolution in the 1960s, food policy has maintained its singular focus on food security, its central and overarching goal. At a national level, policy is aimed at food grain self-sufficiency through price based production incentives. Grain self-sufficiency is the cornerstone of the Indian food security strategy. "The rice/wheat system brought food security to India through the broad dissemination of Green Revolution varieties in the 1960s and 70s. This system is also mainly responsible for the stagnation of agriculture in the country today, and particularly in Punjab" (IFPRI, 2007: 10). Nonetheless, It is feared that for a country like India, "a more-than-a-billion strong nation in which one in every three lives at subsistence level" (Hindustan Times, 12/08/13), any effort to diversify policy objectives, for example by promoting production of high value crops (fruits, vegetables, dairy) or by instituting environmental controls, may undermine national food security.

Indian agricultural policy provides assistance to farmers in the form of price support for specific agricultural products, and subsidies for farm inputs (chemicals, electricity, machinery etc.). These policies, were instituted to "create a favorable incentive environment for the adoption of high-yielding varieties (HYV) of wheat and rice during the green revolution" (Chand, 2003: 2) and are aimed at mitigating risk for producers and ensuring continued production in the face of problems (price fluctuation, climactic events, declining yields). These policies "have been helpful in many ways", Ramesh Chand reports, and have led to the rapid achievement of national food grain self-sufficiency. According to Chand "from a situation of massive shortages, India has emerged as a grain surplus country, and food security has been attained at the national level"(Chand 2003:2) For the International Food Policy Research Institute (IFPRI)"food security has been assured throughout the country by making more grain available, including through public distribution" (IFPRI, 2007: 95). These tremendous food security gains have relied on a system of agricultural price supports which has incentivized a simplified, energy intensive agriculture that persists today and that presents a different set of problems including yield stagnation and overall productivity decline.

These policies create an environment in which government support is contingent on production of specific crops. "The public food grains management system has evolved in such a way that production of wheat and rice has been accelerated by the government contracting these grains at high prices, distorting price and production incentives towards overproduction of food grains. This has led to farmers devoting as much land to growing as much wheat and rice as they can, taking incentives away from growing high-value commodities, or pursuing alternative crops" (IFPRI, 2007:11, 95). The result of such a policy structure has been widespread inefficiencies in the form of food grain surpluses and under-availability of nutrient rich and environmentally beneficial agricultural products such as legumes.

The agricultural price support system in India is the purview of the Food Corporation of India which was established in 1964 with the mandate of providing "effective price support operations for safeguarding the interests of farmers, distributing food grains throughout the country for the public distribution system and maintaining satisfactory levels of operational and buffer stocks of food grains to ensure National Food Security" (FCI, 2014). In 1975 India instituted a Minimum Support Price (MSP) for rice and wheat, seasonally fixing a price at which the government would purchase cereal crops not absorbed by the regular market. Aimed at ensuring national food security through continued production of specific crops, India's MSP was originally set well below the prevailing market price. A second, procurement price, generally slightly above market price, was also used to incentivize production. The procurement price allowed the national government to purchase the needed quantities of grain directly from farmers, benefitting the most productive with higher prices while still providing insurance to the less productive through the MSP. Under this policy configuration the government avoided the problem of surpluses by obligating itself to purchase from farmers, only the quantities of grain required to meet national food security targets (Johl, Formal Interview, 9/28/13).

The MSP was implemented with the intention of “keeping farmers in business in adverse circumstances of market slumps in the post-harvest period” by putting the government into the market as “a buyer of last resort” (Johl, 2013). The MSP originally provided farmers, who were unable to find other markets for their produce, a guaranteed below market price at which the government was obligated to purchase the commodity. Over time and under pressure from interest groups like farmers unions, the procurement price became conflated with the MSP making the procurement price system irrelevant and essentially obligating the government to purchase all of a commodity available in the market at the new conflated MSP/ procurement price (Johl, 2013).

Because the MSP for rice and wheat has risen above market price and is politically difficult to reduce, maximizing production of these crops presents the best option for most farmers. Today the majority of the grain produced in places like Punjab is purchased by the Indian national government for public distribution or as reserve stocks. In the period 1999-2004, for example, 60-90% of rice production in Punjab, and 55-57% of wheat was sold to the public sector (IFPRI, 2007: Appendix A3.4: 99). Although the rising MSP has created problems, in the form of surpluses, and costs to national and state governments food security for many of India’s poorest people, of whom many are also small-scale agriculturalists, has improved. However, the dependence of the poorest sectors of the population on credit for purchased inputs, MSP and public food distribution is likely to become increasingly problematic over time. As input prices rise and yields decline, farm debt will worsen, MSP will also have to rise and the public food distribution system (PDS) will have to effectively expand in order to provide ongoing security for the most vulnerable. According to a report by the IFPRI "grain yields have been declining in recent decades increasing the demand for government support for agriculture"(IFPRI, 2007: 10). Eventually MSP and other price support measures, like input subsidies, may prove too expensive for the Indian government.

Related to the problem of cost, is the problem of agricultural diversification to ensure ongoing productive capacity, rural livelihoods, and proper nutrition. For Dr. S.S Johl, the problem of diversification has more to do with marketing, specifically access to retail markets for small farm produce, than with MSP itself (Johl, Formal Interview, 9/28/13). The IFPRI explains:

> The existing market rules and regulations favor food grains and so different rules and regulations are needed to promote high-value commodities (fruits, vegetables etc). Since wheat and rice dominate the market, the state and Central governments have little incentive to invest in infrastructure that would be more suitable to support high-value agriculture. The system perpetuates because many stakeholders benefit—including wheat and rice farmers, traders in the market, and the staff of the FCI, and operators of PDS.
>
> (IFPRI, 2007: 95)

It is possible that lack of diversity in agriculturally intensive areas of India is due to distorted enforcement of existing policies. Johl reports that MSP covers some 22 agricultural commodities in addition to rice and wheat (Johl, Formal Interview, 9/28/13). In his 2003 article Chand finds that "no system exists on the ground to monitor and enforce MSP for the majority of crops with a listed support price. The MSP system only functions correctly in the case of rice and wheat in five states, and in the case of sugarcane and cotton in a few states" (Chand, 2003:2). He goes on to comment "It looks very strange that politicians and farmers ask for raises in the MSP for specific commodities but rarely bother to ask for implementation of the MSP" Chand, 2003:2). Indeed, one side of the argument goes that agricultural diversity may be facilitated by extension of MSP of a wider variety or crops, particularly fruits and vegetables that are more costly and carry greater risk in production. It appears, however that proper enforcement of existing MSP may achieve similar results. "Enforcing MSP in all the regions is highly desirable, but achieving this goal through purchases by government agencies can lead to enormous problems of unmanageable and unwanted stocks. The problem would further increase with wider coverage of crops. It is just not possible for the government to buy produce everywhere if the price falls below the MSPs. Similarly, it is just not possible to buy produce of every important commodity to ensure the MSP" (Chand. 2003:3).

Effective policy implementation and enforcement emerges as a major stumbling block in Indian food systems. For example, while the PDS was recently expanded in December 2013 to serve over 70% of the national population, serious administrative problems with the existing system including corruption, have not been dealt with and many have expressed doubts over the Indian government's ability to deliver on these promises. The IFPRI reports that

"Leakages from the public distribution system represent significant costs. Estimated national-level leakages in 1999–2000 were 19.7% for rice and 48.1% for wheat and in some states the numbers were as high as 70% of food diverted" (IFPRI, 2007:88). Lack of enforcement for existing MSP shows a similar trend, and poor enforcement would likely plague any policies currently in place, highlighting institutional reform and increasing transparency as necessary components of future policy action.

In terms of meeting food security targets through the necessary production of food grains, India's price based policy framework has been enormously successful. Today India has become a net exporter of grain and can be considered 'food secure' in terms of quantity of food grain produced. However, nutrition security in terms of nutrient availability in food remains a serious problem. In addition to the gap between food and nutrition security, environmental degradation resulting from widespread production of staple grain monocultures, threatens the future productive capacity of Indian agricultural systems, their ability to provide acceptable livelihoods for rural people, and Indian food security as a whole. Despite these threats various pressures contribute to maintenance of the status quo. The national food security strategy hinges on the industrial production of staple food grains. Farmers are reluctant to diversify their farms because production of rice/ wheat rotation is less risky than the production of other, unsupported, crops. Furthermore, investment already undertaken in farm industrialization leads to further complacency and political struggles complicate agricultural policy change.

For Chand "The most important goal of any agricultural development policy in India in the present context should be to promote growth, regional equity, natural resource sustainability, efficiency, nutritional security and quality and balance in production. However, all these goals are becoming casualties of the system of MSP the way it is being implemented" (Chand 2003:2). From all perspectives a reform of Indian price support policy (input subsidies and MSP) is called for, however, mitigation of risk to producers must remain a key objective for policy makers if agricultural diversification and other objectives like nutrition security and environmental sustainability are to be prioritized. A shift away from price supports linked to production coupled with improved market access for small producers, transparency and monitoring for agricultural support could reduce the cost to governments, allowing them to channel scarce funding to other areas of priority for sustainable development.

European Common Agricultural Policy

At the time of its implementation in 1962, the Common Agricultural Policy, like Indian agricultural policy today, was singularly focused on food security. While it still claims 'food security' as its primary goal, over time the CAP has added a number of new goals which are reflective of shifting global attitudes about the complex role of agriculture for development. Sustainable development objectives are varied and deeply interrelated. Food and nutrition security are underpinned by issues of poverty and access and all of these are, of course, underpinned by environmental functioning and sustainability which relates directly to the structure of food systems. Because of the multiplex character of sustainable development, it is reasonable to assume that its objectives would be better met by an agricultural policy environment which supports the multiple services provided by agriculture. The European Commission’s Common Agricultural Policy (CAP) provides a working example of just such a system.

Multi-functionality:

The European Union's Common Agricultural Policy (CAP) is distinguished by its emphasis on the multifunctional role of agriculture in society. "The term *multifunctionality* refers to the fact that an activity can have multiple outputs and therefore may contribute to several objectives at once. As applied to agriculture, the term first came into use in the late 1990s in the European Union" (Abler 2004:8). Among the many 'secondary services' potentially delivered by agriculture are preservation of cultural heritage, biodiversity, climate change mitigation and, in broad terms, environmental sustainability. The multi-functionality of agriculture is gaining currency in policy circles, with many countries adopting policies that acknowledge and support these secondary services. In the US these include "the Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Environmental Quality Incentive Program (EQIP), conservation compliance requirements for farm commodity programs, and federal, state, and local farmland preservation programs. The majority of these programs have more than one objective, with the most frequently occurring objectives being reduction of negative externalities from agriculture, wildlife and landscape conservation" (Abler, 2004:13). Because these objectives are not necessarily related to crop production, price support policies which focus solely on production for food security as in the case of India, are inappropriate for capitalizing on the multiple services delivered by agriculture.

While, like most national agricultural policy, the CAP aims first, at insurance of ongoing food security for European people, it has evolved to include a number of non-food security priorities, including, since 2003 mitigation and management of climate change. "In the European Union, there are hundreds of agri-environmental programs at various levels of government. These programs are usually voluntary and generally compensate farmers for following certain management practices" (Abler, 2004:13). The CAP includes initiatives and payment structures aimed at ensuring the economic vitality of rural life and the maintenance of European aesthetic identity among a host of other environmental objectives.

It appears that the gradual transition away from price support and towards a system of direct, income support payments to farmers, has enabled the European Commission to establish multiple foci, both food and non-food objectives, within a single policy framework. Reduction of agriculture chemical usage, the preservation of wild and uncultivated spaces on farms, the creation of ponds or other landscape features, the plantation of trees, hedges and other woody perennials, the maintenance of grassland and pasture, the preservation of biodiversity and wild life habitats, management of water resources like springs and streams, landscape sequestration of carbon to combat climate change, the entrance of young people into farming, and preservation of the scenic values of landscapes are among the services for which the CAP compensates farmers (EC, 2013:12).

The EC's CAP demonstrates "an increasingly common policy approach in agricultural systems: the provision of agricultural subsidies for goods and services beyond the production of marketable food and fiber. This 'multifunctional' approach aims to improve sustainability (e.g. through like wildlife-friendly farming)" or other alternative approaches like food system integration (Mattison et al, 2005:611). Abler observes that policy transaction costs to governments could also be reduced "by using one policy instrument to achieve multiple objectives"; for example, by using a system of direct payments, as Europe has done, to address the multiplex problems of agriculture for development. "Tinbergen's (1952) well-known maxim—*at Least as many policy* *instruments are required as there are policy objectives*—need not hold. Agriculture has a wide variety of multifunctional attributes and it may or may not be efficient to have a separate policy for each of them". (Abler, 2004:12-13)

Public Goods:

"The primary function of agriculture is to supply food, fiber, and industrial products. However, globally agriculture is a source of a number of public goods and externalities" (Abler 2004:8). Public goods from agriculture include preservation of wild, aesthetically or culturally valuable landscapes and spaces, rural economic vitality and poverty reduction, food and nutrition security, climate change mitigation and may others discussed at length above. Today, European agricultural policy aims not only at reducing negative externalities from agriculture but also at increasing its public benefits. According the CAP, farmers, in their dual role as both producers and stewards of agro-ecosystems "provide public goods from which the whole of society – present and future – benefits" (EC, 2013: 12) and they should, therefore, be compensated for these services.

In its 2012 report "The State of Food and Agriculture" the UN FAO asserts that all government expenditures in agriculture should be channeled towards public vs. private good. Spending should go towards projects that have large public returns such as education and extension services and basic infrastructure as opposed to product or fertilizer subsidies which are often politically popular. The report states: "Investing in public goods for agriculture yields strong returns in terms of both agricultural productivity and poverty reduction" (FAO, 2012e:15). Out of the Rio + 20 conference in 2012, emerged the 'zero hunger challenge', the "dual goal of eradicating hunger and making agriculture sustainable", in no small part through "improving the quality of public sector investment in agriculture" (FAO, 2012e: 9,19). Integrated agriculture, because of its high potential for delivering external benefits, is an obvious target for agricultural support aimed at maximizing public good. The CAP is evidence of this, having built in a number of incentives and payment structures aimed at promoting integrated practices with external benefit, like agroforestry.

The issue of how to value these public goods emerges as a major research challenge for incentivizing environmentally sustainable practices through policy intervention. As of yet, markets do not compensate farmers for the external public benefits provided by well managed agro-ecosystems. This is one of the areas targeted by the CAP, which directs funding towards farmers who provide ecosystem and other services, such as water table maintenance, promotion of biodiversity and preservation of cultural value and aesthetics in landscapes. Even without precise valuation, the European experience illustrates that it is possible to shift from an agricultural support structure focused on output of specific crops towards one that incentivizes activities and practices deemed to deliver the most public good. "Available evidence indicates public goods associated with agriculture are not joint with commodity production per se, but rather with land use practices and with agricultural structures"(Abler, 2004:14).

Outcomes

Until the 1990s the CAP pursued food security through a system of production subsidies and price support, much like the Indian system today. Similarly, the original CAP, designed to combat food shortages after WWII, focused on food security at the expense of other concerns, like environmental sustainability. “In its early years, the CAP encouraged farmers to use modern machinery and new techniques, including chemical fertilizers and plant protection products. These were necessary because the priority at that time was to grow more food for the population” (EC, 2013:14).

Europe’s market support approach ultimately proved “too successful at incentivizing production” and resulted in Europe’s famous “mountains of food” (EC, 2013:7), massive food surpluses which had to be subsequently disposed of. Today, India is experiencing a similar phenomenon. According to the Wall Street Journal, India continues to export surplus food grains despite the implementation of its new food security policy which will provide subsidized grain to over 70% of its population. “India has been holding on to excessive grain supplies. As of July 1 2013, Indian government granaries were stocking 73.9 million metric tons of food grains, 2½ times more than the minimum buffer level” (Mukherji, 2013).

It seems clear that price supports for certain crops have the effect of over-incentivizing their production and under-incentivizing the production of unsupported crops (which often carry more pronounced environmental and health benefits - as in the case of pulses).[10] These policies lead to surpluses of supported commodities. In response to the agricultural surpluses experienced in Europe, the CAP was revised in 1992, shifting its focus “from market support to producer support.” The CAP now directed its aim to eliminating surpluses by reducing agricultural subsidies, which represented huge costs to the government. “Price support was scaled down, and replaced with direct aid payments to farmers” (EC, 2013:7).

[10] See ‘The Green Revolution & its Repercussions’ pg.63

The cost of government support for agriculture is a major issue. This is acutely true for developing countries in a time where support for industrialized production of prioritized commodities (grain) is becoming more expensive in response to rising input costs and declining yields. In a country like India, where agricultural subsidies amounted to 3% of GDP in 1999-2000 (The World Bank Group, 2011), reduction of subsidy costs could have positive impacts for overall development. According to the World Bank, Indian agricultural price support is "crowding out productivity-enhancing investments such as agricultural research and extension, as well as investments in rural infrastructure, and the health and education of the rural people" (The World Bank Group, 2011). It is likely that a re-direction of agricultural support in India towards activities that deliver greater public good and reduce the need for support over time, activities like integrated farming, extension services and construction of rural infrastructure, would have positive implications for development objectives like poverty eradication and environmental sustainability.

The major 1992 revision of the CAP away from commodity price support and towards direct payment for provision of public benefit and ecosystem services (water table maintenance, and the retention of wild spaces on farms etc.) coincided with the 1992 Rio Earth Summit, or the United Nations Conference on Environment and Development (UNCED) and the conceptual birth 'sustainable development'. In 2003 reforms were taken further to include a wider range of services and in 2011 the CAP's mandate was expanded still further to include responding to and combating climate change in the agricultural sector. Europe's system of direct payments to farmers makes eligibility for financial support contingent on environmental stewardship and other factors, delinking it from production and enabling multiple objectives. This system is more fitting with the complex nature of development goals.

It is likely that a multi-focal policy framework aimed at making uses of integrated food systems could reduce the cost of agricultural support for the Indian government, as it has done in Europe. Because integrated food systems are far less dependent on inputs than are conventional systems, their implementation could reduce the cost of input subsidies. As by nature diverse, use of integrated approaches means diversification of production. Diversity of production would have a cascading effect for the diversity of local economies, via creation of companion industries and development of markets and supply chains for a greater diversity of crops. As the structures of markets and supply chains develops and ecosystem functioning in integrated systems increases- providing more services and better yields- government can gradually scale back its price support for agricultural commodities and the inputs required to produce them. Money saved in agricultural support could then be channeled towards other development objectives.

Removing Price Support:

Worldwide there is much fear and uncertainty over the consequences of removing agricultural support altogether. In India, opponents of the ever increasing MSP complain that it only helps large farmers and only in a few states, and that it causes inflation, making basic food stuffs unaffordable to the poorest segments of the population. On the other hand proponents of MSP claim that, in a country where “farming is occupation number one” and where “farmers are mostly poor” (Times of India, 2014) raising and extending the MSP would have positive implications for Indian development as a whole.

What would happen in the wake of a large scale removal of government support for agriculture is uncertain. “In the European Union, there are concerns that significant cuts in agricultural price supports could lead to widespread agricultural land abandonment or conversion to urban uses” (Abler, 2004:11) These concerns are echoed in India “take away meaningful MSP, and farmers would abandon farming en masse” (Times of India, 2014). Both removal of and increases in MSP pose threats to national food security in India. “Eliminating assured income support for farmers might lower some prices in the short term, but then the country would be stuck with troublesome shortages in the long term” (Times of India, 2014).

Worldwide, the impacts of agricultural deregulation are unknown. “Farmers could cut costs and manage risk by reducing inputs and diversifying their farming systems, as seen in New Zealand with potentially beneficial outcomes. By contrast, farmers could follow market trends and expand production of high-priced commodities, with the resulting reduction of crop diversity being potentially detrimental, as in Canada” (Mattison et al, 2005:611). At the very least it is clear that removal of MSP would prove politically difficult if not impossible in a country like India. Furthermore, the developing world is unlikely to reduce government support for agriculture as long as Western (US and European) agriculture remains heavily subsidized. The most feasible way forward would be to continue agricultural support to but to de-link it from production, as Europe has done, thus eliminating many of the associated problems including unmanageable surpluses, and raising food prices.

Price Support vs. Direct Payments:

In his 2005 piece Abler concludes that price support policies like MSP, which are targeted at outputs, are not able to promote multifunctional agriculture in an effective manner. However, the question of whether support policies, like the European direct payments, which are de-linked from production would effectively incentivize a multi-functional or integrated agriculture in a country like India, remains unanswered. Given the spotty enforcement of existing support policies, oversight could become a serious issue. Increased transaction cost of such a policy change could also prove problematic. "Estimates of administrative costs for agricultural programs suggest significant differences across programs. It is relatively easy to transfer funds to farmers based on acreage or production, but more difficult to ensure that environmental or land management conditions are followed in return" (Abler, 2004:13, 14).

While, a re-direction of agricultural support in India toward direct income support based on conditionalities presents a new set of problems these problems may not be insurmountable. One reason for the higher costs of administration for these types of policies may be scale. "These programs have been relatively small in scale to date. Consequently, fixed administrative costs for agri-environmental programs (costs independent of the number of farms covered) are relatively large" (Abler, 2004:13). Studies conducted in the US have found that economies of scale can be achieved with respect to the number of direct payment agreements extended to farmers. These studies also "observed significant learning-by-doing effects, with administrative costs falling as the number of years of experience in managing agreements increased" (Abler, 2004:13). These findings indicate that the more widely such a system is implemented and the degree to which it is successfully enforced could significantly reduce the increased transaction costs. Further, agricultural modeling technology has shown that cropping patterns do respond to these types of price incentives. “In the upper- Mississippi river basin changes in tillage decisions were modelled following the introduction of payments for the use of minimum tillage” (Mattison et al., 2005:612).

Given the advantages and disadvantages involved in de-linking agricultural support from production and channeling it towards social and environmental conditionalities, the question becomes “Are the savings in transaction costs achieved by using agricultural price support programs sufficient to outweigh the social costs of these programs due to market distortions and negative externalities? ” (Abler, 2004:14). In India today, the answer to this question is certainly no. In the face of declining yields, rising input costs, and widespread environmental degradation the Indian system of supported staple grain monocultures aimed at national food security is simply unsustainable, and alternative policy frameworks must be considered. Indian agriculture would likely benefit from the adoption of a more ‘European’ perspective which “considers agricultural land in a broader context and requires consideration of alternative conservation strategies within a more holistic framework” (Mattison et al., 2005:614). Such a perspective rewards multi-functionality and provision of public goods and could go far towards promoting food system integration.

Policy Conclusions

If we accept the argument that food system integration can contribute to multiple sustainable development goals including the sustainable intensification of agriculture and the increased provision of public benefit from agriculture, then agricultural policy must aim at food system integration. In this view the relationship of agriculture to development is multi-faceted. It follows that multi-faceted food systems like IFS, are better positioned to address the multiple and interrelated objectives of sustainable development.

Currently, Indian agricultural policy focuses primarily on a single development objective- food security. Price supports (MSP and input subsidies) have been successful at achieving food-grain self-sufficiency and improved food security for India, in terms of available quantities of food grain. However, these policies have fallen short of meeting other objectives like environmental sustainability, nutrition security, preservation of traditional and place based cultures, and agro-economic diversification through the development of companion industries and improved market access for small farmers. Because of its flexibility, a system of direct, income support payments to farmers, as in Europe's CAP, may be better able to simultaneously address multiple development goals without compromising financial support for farmers or national food security. A restructuring of Indian agricultural policy to institutionalize the multiple objectives of food and agriculture for development, may be prudent and possibly cost effective for the government.

Europe's experience of moving away from market price support towards direct producer support in order to reduce government spending, eliminate surpluses and encourage environmentally sound farming practices could serve as a useful model for Indian policy makers. There is reason to believe that greater levels of integration in farming systems could reduce the cost of government agricultural support over time. As the need for inputs is reduced and productivity is restored through improved ecosystem functioning, it is likely that government support for agriculture can be scaled back or channeled towards other development goals like health care and education. Furthermore direct income support payments for farmers have the added benefit of leaving markets undistorted and of being less contentious than price support measures in terms of international trade politics.

As we have seen, agricultural policy is one of the factors that most directly influences the degree to which integrated food systems are put into effect. Based on the European example, it is clear that government support for agriculture in the form of direct payments to farmers can be utilized to achieve a multiplicity of development goals including the greater integration of food and agricultural systems. In India, the addition of income support payments for farmers to the existing policy framework will have limited scope for achieving these goals if policy is not also adapted in other ways. First, reduction of the current price supports for food grains (both MSP and input subsidies) which discourage diversification, and serve to maintain the status quo of agro-ecosystem simplification through heavy use of energy and inputs, will have to be dramatically scaled back. In order to ensure ongoing food security, these supports must then be replaced with direct payments to farmers and a fine-tuning of the public food distribution system on which the neediest depend. Capacity building through infrastructure, education and extension services, gender empowerment initiatives and the mobilization of social capital to create more and better markets for diverse, high value and/or local products at local levels and in rural communities will also be critical if a transition from price supports for agriculture to a system of direct payments to farmers is going to be successful at promoting food system integration in India.

DISCUSSIONS, CONCLUSIONS & FINAL THOUGHTS

Because of the enormity of the questions posed in this study and the limited scope the research, this concluding section must also make mention of many of the critical issues related to the topic of integrated food systems for development which have not found their way into the main body of this thesis. The following section presents a number of important points for brief and general discussion as well as the overall conclusions drawn through the course of this research.

Consumption

This paper focuses on food *production* systems, neglecting a critical piece of the sustainable food puzzle: consumption. Consumption patterns and their relationship to food and to sustainable development is a topic large enough for its own study but nonetheless is given very brief treatment here.

Over the past 30 years global consumption patterns have changed dramatically. The global south has experienced rapid development which has meant rising incomes, urbanization and growing demands for all types of 'lifestyle' and consumer products including red meat, dairy and processed foods. Growing affluence and development in the global south has also meant greater demands for energy. This coupled with declining reserves and rising costs of fossil fuel have put pressure on agricultural production to meet food needs, including greater demands for meat, as well as energy needs for biofuels. Growing demand for these commodities has led to the expansion, intensification, and simplification of farming systems around the world.

The issue of consumption is a difficult one. It raises delicate questions like: who as the right to consume what? How much? What are the differences between necessary and luxury consumption? And how can the great global disparities between consumption levels be remedied? Countries have taken staunch and sometimes heated positions on the issue. In 1992 then US President George HW Bush famously proclaimed, in response to pressures to cut resource consumption: "The American way of life is not up for negotiations. Period."; "While developing countries, such as India, have long demanded a distinction between luxury and subsistence consumption" (Clémençon, 2012: 14). These debates belie an inevitable reality; the earth simply does not have the carrying capacity to provide all of earth's people with sub-urban middle class lifestyles and to support the consumption habits implied by these lifestyles. The pressing nature of this reality contributes to the divisive nature of the topic, as attempts to alter consumption patterns will be enormously difficult, disruptive and costly for all counties. In this light global inequalities also become more pronounced.

It can be argued that 'globalization', the rapid spread of information technology and the related 'westernization' of many parts of the world has influenced changes in consumption patterns. At the household level, where opportunities to change consumption patterns may be greatest, "people often feel that extravagance and waste are elements of their sense of freedom and affluence. In affluent societies new extravagant expressions of consumption develop with each generation which in succeeding generations degenerate into a habitual norm and eventually an addictive necessity" (Holmgren, 2006:113). Through the course of development, consumer goods which were once considered a luxury, such as electrical appliances (refrigerator, stove), come very quickly to be seen as necessities.

Indeed, most of us in the ‘developed’ world cannot imagine our lives without these goods and would argue that our lives are better for them. This raises the critical question: with limited resources, who is entitled to these types of lifestyle necessities? Reductions in household consumption become problematic also at the economic level, where development, aided by economic growth is in many ways contingent on consumption of these goods. “Governments do not generally support major social changes away from addictive consumption, even though the social and environmental benefits would be great, because the growth economy is inextricably tied to consumption” (Holmgren, 2006:113).

In terms of food, affordability is a major issue. For the world’s poorest, access to diverse and nutritious foods is often totally precluded by price. For the growing class of urban consumers, preference for ‘high value’ produce (vegetables, meat etc.) is constrained by price. This could have positive environmental implications for certain products, reduced consumption of red meat, for example, due to high prices would have positive environmental impacts, but could have negative impacts on nutrition for some and positive impacts for others. For other products the impacts could be negative, lack of incentive for production of diverse crops (fruits and vegetables) as opposed to grain because of lack of demand for high priced foods, could have negative environmental and nutritional outcomes. In all cases, the price of food and its affordability to the poorest is a central concern of sustainable development. The prices of foods determine what and how much we consume, and those consumption habits are the foundations of our food systems.

The scope of this paper is not wide enough examine in detail the role of consumption and changing consumption patterns for sustainable food systems. It is clear that the future sustainability of food systems is circumscribed by growing and rapidly urbanizing, middle class populations. Food production is of course only half of the picture. Consumption is of tantamount importance when it comes to making food sustainable, and just as food production systems are in dire need of change in response to some generally observable phenomenon, so are consumption habits. These trends will have to be addressed. Consumption patterns will have to change, and changes in these toward preferences for local, slow and niche foods, and a willingness and ability to pay for them - will go far in promoting more integrated production techniques.

Gender, Equity, Health, and Participatory Approaches

Gender is a key development issue which also links to food systems. Millennium Development Goals 3 and 5 are: 'Promote Gender Equality and Empower Women' & 'Improve Maternal Health', respectively. In most households, particularly in the developing world, women are responsible for household food security. Because of their responsibility to the household, women are often disproportionately affected by hunger and malnutrition. When women have poor nutrition there are obvious negative implications for maternal health and healthy pregnancies, which in turn have implications for child mortality, MDG 4: 'Reduce Child Mortality.' Efforts to address food and nutrition security must also address how food is distributed within households, targeting women as priority for intervention. It is possible that greater diversity of the food basket, both in the farming system and in the market would have positive effects for overall household nutrition, including female nutrition which could improve maternal health and child mortality rates.

Prevailing gender norms in many areas have served to disadvantage female headed households in economic terms. In areas where women have less access to capital, credit and secure property their farms are often less productive than those of their male counterparts. This means that female headed households are more vulnerable to food insecurity than are male headed households. This dynamic has been widely recognized by development partners (governments, NGOs, international organizations) and many projects have been launched targeting women for microcredit, agricultural extension and marketing training etc.

Ensuring the food security and economic independence of women will involve what the United Nations terms ‘participatory approaches to development’. Growth and development that uplifts the poorest and most vulnerable segments of the population, including women, will require their involvement and participation in planning and implementation. Based on the exhaustive study International Assessment of Agricultural Knowledge, Science, & Technology for Development (IAASTD), released in 2008 by a collaboration of major development actors (UNEP, UNDP, World Bank, UNESCO, GEF etc.), the United Nations concludes that “an essential element of the successful development and long-term adoption of ecologically sound, sustainable systems is the involvement of farming communities, small-scale farmers and women and the integration of socio-cultural and socio-ecological dimensions and local knowledge into any decision about food security and sustainability. Participatory approaches are important in mainstreaming innovations towards sustainability” (FAO, 2011a: 56).

Context

Clearly IFS would have different applications in different contexts, different costs and benefits under different circumstances. Because of their complexity and specificity, a system that is successful under one set of conditions may not be made to easily work under another. This is one of the obstacles faced by IFS for wider implementation but it is also one of their strengths. IFS are, by nature, site specific and as such, more responsive to local needs and circumstances. Critics of industrialized agriculture have argued that the "unsustainability of modern methods is due, in part, to mass solutions applied to diverse conditions. More sustainable systems will be characterized by site-specific and situation-specific solutions" (Holmgren, 2006: 218). In order to apply IFS more widely, substantial new research will be needed into which designs and combinations are appropriate for which contexts. For example, which food crops (most of which require full sun) can be adapted to be grown under the cover of forest? It appears that existing research has only just begun to scratch the surface of available combinations of plants, animals and other farm elements which can be used to meet human needs.

At the moment IFS may be better fitted to some contexts than to others. For example, countries with large reserves of unskilled labor could stand to benefit greatly from the implementation of agricultural systems that were more labor intensive, and the development of companion industries to add value, generate employment, and diversify rural economies. On the other hand, countries with readily available capital and high cost labor may find it more beneficial to continue with capital intensive agriculture until the rising costs of inputs necessitate change. In all cases, changing global circumstances will force consideration of integrated production methods across a wide range of countries and contexts.

Scale

The issue of scale, both spatial and temporal is central to the question of whether or not IFS will be able to meaningfully contribute to the realization of sustainable development goals. Integrated food systems tend to be small scale (although there are exceptions), generally used at the household or small farm level. Because they are significantly more complex in terms of management, up-scaling may result in a level of complexity greater than what can be reasonably managed. These issues have limited the spatial scale of IFS. Time scales are also a critical element of sustainable development. The demands of sustainability dictate that food systems meet present needs without compromising the ability to meet future needs in the process. Current food systems, particularly industrial food systems are designed to meet needs in the short term with little concern to long term implications. This short sightedness is arguably responsible for the food crisis we are now faced with as a planet, and it would appear that true efforts to address sustainability issues must consider various time frames, and design with longer-term perspectives.

Space:

With policy support and adequate funding, sustainable crop production intensification could be implemented over large production areas, in a relatively short period of time. The challenge facing policy makers is to find effective ways of scaling up sustainable intensification so that eventually hundreds of millions of people can benefit.

(FAO, 2011b:25)

Perhaps the most pressing question this study presents is also the question it is least able to answer. How can IFS be up-scaled to meet global food needs? The UN calls for the scaling up of successful systems, like IFS which can be used to sustainably intensify production. It identifies some critical obstacles like policy and limited funding, but falls short of suggesting how up-scaling may actually be accomplished. The need for cross-sectorial cooperation also emerges as a key issue for up-scaling IFS. Managing large, integrated systems will require the coordination of many diverse actors: various government sectors, local, state, national, and global governments, local communities, and businesses etc.

The multifocal and transdisciplinary nature of IFS has been an obstacle for both their wider implementation and their spatial scale. Disciplinarity, the segregation of knowledge and learning into individual disciplines remains characteristic of modern formal education and development thinking. Segregated approaches to understanding, limit the capacity of individual disciplines for addressing problems, like sustainable development, which cut across disciplines. Up-scaling IFS to meet larger needs will require cooperation, commitment, and coordination among many different sectors and actors. To date, this complexity of management has amounted to a total lack of management as IFS do not fall under the purview of any one government agency, requiring instead the cooperation of agriculture, forestry, rural development and trade ministries, among others. The need for cooperation and coordination has played a role in keeping IFS small up to this point.

The size of our endeavors, our population, our concentration in cities, the global reach of our economies and supply chains, demonstrate a reliance on readily available energy. Systems that cannot achieve this sort of scale, the home garden for example, lose credibility in discussions of large scale or global problems like food security and environmental sustainability. “In agricultural research and development, the issue and opportunities that affect whole industries receive the majority of funding and attention. Because most sustainable agricultural solutions are small-scale, they tend to fall through the net and are ignored” (Holmgren, 2006:187). However as energy becomes less readily available, smaller scale systems begin to look more promising.

Before industrialization, food systems were, by nature at human scales, as they depended on human management and energy from human and animal labor. This is true of the majority of today’s IFS as well. Today these systems are considered small scale in comparison to the large mechanized farms and agribusiness systems that have become the norm, particularly in the developed world. Despite their limitations of scale, “small farms produce about 4/5ths of the food supplies in developing counties, supporting billions of people. Over half of the world’s rural poor are small farmers” (FAO, 2014). These statistics show clear links between small scale food systems and issues of poverty and food security for the poorest people.

Given their ability to meet current food needs in many parts of the world, it is likely that small scale and integrated food systems could cope with growing global demand, and be intensified to produce more food on existing cultivated areas. One option for increasing the output from small IFS is to up-scale them, or to make them spatially larger. This approach could be problematic as larger systems demand larger inputs of labor and energy, and greatly increase the complexity of management. Complexity and labor intensity could be beneficial for development efforts in areas where labor is abundant. Larger size of individual

IFS, if it can be properly managed, may also amplify the positive effects of ecosystem functioning, delivering more services than smaller systems. For example forest scale systems could preserve more bio-diversity and sequester more carbon, in addition to generating greater output of useable products, than could smaller holdings. Increasing complexity, however, brings with it the urge to simplify in order to control. Up-scaling of IFS makes these systems vulnerable to the same pitfalls that have compromised the benefits of conventional agriculture. If systems become so large that they must become less complex, or that they lose their specificity and loyalty to place, then many of their benefits may also become compromised.

An alternative approach to up-scaling would be not to increase the size of individual systems but to build stronger networks of small systems. The findings of this study suggest that building networks based on a 'hub and spoke' model for production and distribution may be the best way to up-scale integrated food systems (Johl, Formal Interview, 9/28/13). The hub and spoke model, where individual small farms sell their produce to a central distribution center, is a model that is currently in use among organizations that promote integrated farming and/or direct marketing for farmers. Two examples are Navdanya (Dehradun) and the Sangh Milk Cooperative (Wardha). Keeping farms small has the benefit of accessibility to small, poor, and marginal farmers. If food systems remain small then their complexity remains more manageable and it is likely that they will remain more site specific and appropriate for individual contexts. Building stronger networks will also mean building new value chains. Navdanya and Sangh show that this is possible however will likely require capacity building initiatives, and the mobilization of social capital to build skills and relationships, as these organizations have done. The evidence from this research shows that the up-scaling of IFS through the building of networks is a feasible approach to the utilization of IFS to meet larger scale needs however the question of how to reconcile the inherent sustainability characteristics of traditional, pre-industrial food systems with the needs of contemporary global food security is key and remains unanswered, highlighting a critical arena in which new research is called for.

Time:

Central to the issue of sustainable development is the tension between short-term and long-term. Arguably, older development paradigms (development as economic growth) prioritized short term gains, neglecting the long-term implications of human activity. *Sustainable* development adds a much longer timeline to conceptions of development, implying standards of intergenerational justice and indefinitely sustained productivity. The United Nations identifies the "focus on short term gain over long term security" as "foundational to the problem of building a supportive policy framework for the sustainable intensification of agriculture" (UNEP, 2011:5). The central argument of the UNEP document *Food and Ecological Security* is that it is critical to analyze the "trade-offs between short-term gains and long-term impacts on ecosystems and their services before policies are developed and implemented with regards to agriculture" (UNEP, 2011:5). In spite of encroaching environmental limits, lingering fears over uncontrolled population growth and inability to produce sufficient food (short-term goals) continue to overshadow environmental concerns (long-term goals) in policy debates.

The task of imagining and planning for time scales beyond a few generations is a difficult one. The immediate problems of today, like global food security, often supersede our concerns for the future. In Berry's words: The "demands of immediate use eclipse the demands of continuity" (Berry, 1996: 94). Most development outcomes are measured in periods of five or ten years, sometimes a human lifetime but rarely longer. Development theorist Nederveen-Pieterse remarks that the standard timeline of development policy and lending is "The mid-term time span of a generation, or shorter, down to five years or so" (Nederveen-Pieterse, 2010:162). Holmgren observes "human nature, to a surprising extent is bounded by the human scale of the senses and personal memory. We have a strong bias towards short-term thinking within our own lifetimes (Holmgren, 2006: 129).

In order to achieve sustainable development goals via adoption of long-term perspectives and action plans, humanity will have to develop more detailed measurement and observation skills. "Observation skills are necessary to perceive the subtle signs of changes over time-scales much greater (slower) than the observation period. This is a critical issue in making sense of the broader issue of sustainability" (Holmgren, 2006: 264). Some theorists argue that our ability to actuate change in our lives and our environment has outpaced our ability to observe and control the consequences of our actions. This disconnect between action and observation has contributed to many of the problems now experienced as a result of conventional food systems. "The increasing human ability to *do* things has outstripped the evolution of our ability to *understand* both what we should be doing and the full implications of what we are now doing" (Ehrlich, 2002 in Swilling et al., 2012:17).

The issue of timescale is critical to sustainable development. "Since development is concerned with the measurement of desirable change over time it is chronocentric"

(Nederveen- Pieterse, 2010:162). In order to meet sustainable development goals, it seems that humanity must learn to think and to measure things in longer terms, to understand small and subtle indicators of change, and to develop action plans that take into account continuity over time. According to Nederveen- Pieterse: For more complex awareness, what is needed is combining multiple time frames and balance between ‘slow knowledge’ and the ‘fast knowledge’ of instant problem solving” (Nederveen- Pieterse, 2010:162). Integrated food systems are examples of efforts to include more complex awareness of both time and space. Systems like ‘terra culture’ Johnathan Foley’s conception of ‘agriculture for a whole planet’ in which the functioning of the entire planetary ecosystem must be considered (Foley, 2010), and Permaculture Mollinson and Holmgren’s attempt to establish a ‘permanent’ human cultivation system ‘perma-culture’, considering time scales of 200 years or more, show that systems which consider spatial and temporal complexity are gaining currency and may be viable options for sustainable development planning including the sustainable intensification of agriculture.

Final Thoughts

While this research is of limited scope, and falls short of fully addressing some of the larger, more abstract questions posed or implied, it does provide some insight into the overarching question: In which ways and under which circumstances do integrated food systems help to meet sustainable development goals? This research also allows for the identification of some clear avenues for further research and for policy interventions that would better enable food systems to meet increasingly nuanced and humanistic sustainable development goals.

Integrated food systems *do* have the capacity to directly address several established sustainable development goals, including MDGs 1. Eradicate extreme poverty and hunger and 7. Ensure environmental sustainability and would likely contribute to the meeting of other goals related to health, nutrition and food including MDGs 3. Promote gender equality and empower women, 4. Reduce child mortality, and 5. Improve maternal health. In addition to meeting these established goals, IFS can contribute to general improvements in human well-being based on a number of not-yet developed indicators such as the spiritual, cultural and aesthetic values.

Integrated food systems can contribute to poverty alleviation efforts by creating jobs in rural areas and by diversifying agricultural economies. When poverty is reduced food security will improve both in terms of quantity and quality. Because they provide diversity IFS help to ensure improved nutrition and environmental sustainability, both of which are fundamentally underpinned by diversity. In addition to ensuring better nutrition at the household level, diverse IFS provide a space in which food traditions and cultures of place can be preserved and enacted contributing to overall human wellbeing. IFS, if properly designed and managed, can improve the functioning of agro-ecosystems over time. IFS enable agricultural systems to deliver and improve ecosystem services, while meeting human provisioning needs. As ecosystem functioning improves in response to integrated approaches, overall provisioning services of farming systems also increase. In addition to provision (food), improved ecosystem functioning helps to ensure continuity in regulating (carbon sequestration, water table maintenance) and other (cultural, intangible) services.

If integrated food systems can contribute to the eradication of poverty and hunger and help to ensure environmental sustainability then they could also have positive effects for gender equity and female empowerment, child mortality rates, and maternal health. Female headed farming households represent some of the poorest people on the planet. IFS which provide unique opportunities for small, poor, and marginal farmers could serve to empower female farmers and improve their productivity. In most parts of the world, women are primarily in charge of household food and nutrition and also suffer disproportionately from malnutrition. Overall improvements in household nutrition via adoption of ecosystem based, diverse farming systems would likely improve the food and nutrition security of women and children. Improved nutrition for both women and children could clearly contribute to better maternal health and reductions in child mortality.

In spite of these benefits, the potential of IFS to meet sustainable development goals is under-realized. For a number of reasons, IFS are not widely implemented. These reasons include inherent limitations of scale and complexity of management, but it is the assertion of this researcher that these limitations can be overcome if policy and public perception shift in favor of alternative approaches to food production. Such a shift is emergent in development discourse. The need to intensify food production to meet growing global food needs and to do it in a way that enhances and preserves the ability of ecosystems to function and deliver services, is salient. The need for sustainable agricultural intensification has raised doubts over the ability of conventional food systems to achieve this goal. Large scale sustainable intensification will require new and innovative approaches to food production. Food system integration presents a logical way forward.

Current policy frameworks in many parts of the world are discouraging to IFS. Many of these policies, including price support mechanisms for agricultural products and inputs, are aimed at food security and/ or economic vitality. In the short term these policies have been fairly successful. In India, for example, price supports instituted to facilitate the adoption of green revolution technology, have led to tremendous improvements in national food security and unprecedented growth in the agricultural economic sector. However the simplified production systems which result from these policies are undermining the ability of ago-ecosystems to deliver all ecosystem services, including food provisioning, in the long term. In order to ensure long term food security and sustainable development for rural, agricultural areas, policies must be re-structured to provide incentives for realizing the multiple services delivered by diversifying and integrating food systems both horizontally (within farming systems) and vertically (within supply chains). Counties, the EU being the chief example, that have transitioned from price support systems for agricultural products to direct income support payments for farmers have been more successful at diversifying their agricultural sectors and implementing sustainable farming practices.

It is unlikely that dramatic changes in the policy environment will take place without a change in public understanding of IFS. It is only recently that IFS for food and agriculture are coming to be widely understood. Up to this point many of the benefits delivered by these systems including critical but intangible regulating services, have been ignored and provisioning services have received disproportionate attention. Measurements of productivity in food systems have revolved around outputs of individual crops, ignoring the efficiency of overall system functioning and the measure of output in relation to inputs. These skewed measures have led to the perception that conventional farms are significantly more productive than IFS. However, when all services, inputs, outputs, and externalities (both positive and negative) are taken into account it becomes clear that IFS can achieve levels of productivity which are comparable or superior to the productivity of conventional food systems. Today, as the critical role of all type of ecosystem services is becoming more widely recognized, the numerous benefits delivered by complex, diverse, IFS are increasing in value.

The ability to implement and to upscale IFS is constrained by agricultural and other policy in many parts of the world, certainly in India. Policy intervention to promote IFS is, in turn, constrained by negative public perceptions and lack of understanding. Both of these obstacles could be better overcome by increased funding at all levels, and significant new research and development around IFS. It is clear that very little research has been conducted into the full potential of IFS for development and for application in diverse contexts. For example, forest gardens, agroforestry and 'food forests' are all established integrated systems for producing food and other products in forested areas. Their wider application is constrained by lack of knowledge of viable species for forest environments. If more edible species can be developed and more synergistic relationships can be identified between food crops and forests, then the pressure to fell forests for agricultural production could be greatly decreased. Furthermore, countless successful projects have been established throughout the world, but are severely limited in their scope due to lack of funding for up-scaling.

Very real concerns over global food security continue to constrain the wider applicability of IFS. I argue that IFS can overcome the obstacles that face them and meet numerous sustainable development goals including, the central aim of any food system- to provide enough food to feed the population. This will require changes in public perception.

Perceptions are already shifting and will likely shift further as current food system become less viable in response to environmental and economic pressures. New research into IFS design and applicability across diverse contexts, the development of new varieties, species combinations and combinations of other farm components, as well as funding for the up-scaling of successful pilot projects will go far towards shifting public perception in favor or IFS. As public and scientific understanding of IFS, their limitations and benefits, improves then changing policy will become easier. Finally, re-arranging policies to support diverse ecosystem approaches, perhaps by transitioning from a system of price supports to a system of wealth transfer based on conditionalities, will be necessary if the full potential of IFS for meeting sustainable development goals is to be realized.

APPENDIX I: List of Informants

FORMAL INTERVIEWS

Farmers: Integrated

1. Gurpreet Singh Shergill: Interviewed 09/12/13; Majhal Khurd Village, Sanaur, District: Patiala, Punjab

- Age 42; land holdings 14.5 acres; Farming 15 years (PAU, 2013)
- Integrated farm (recently transitioned from conventional), specializing in commercial flowers, but also included fish ponds, rice/wheat rotation, vermi-compost, and small onsite processing for retail.
- Mr. Shergill appeared to be doing very well, and had won numerous awards for his progressive practices.

2. SH. Kamaldeep Singh: interviewed 09/17/13; Langeri Village, Garhshankap, District: Hoshiarpur Punjab (Translated by Amarpreet)

- Age 44; land holdings 2.5 acres; Farming 27 years (PAU, 2013)
- Very small, tightly integrated (ancestrally integrated) farm with kitchen/ home garden, livestock, and market crops interspersed. The main source of income was agroforestry (poplar eucalyptus and other trees).

- Mr. Singh professed to be satisfied with his (seemingly comfortable) lifestyle and had avoided debt by developing small industry and by meeting most of the family needs on the farm.

3. SH Narinder Singh Dhoor: interviewed 09/17/13; Ajjowal Village, District: Hoshiarpur, Punjab (Translated by Amarpreet)

- Age 38; Land holdings 2.5 acres; Farming 8 years (PAU, 2013)
- Integrated farm (recently transitioned from conventional) specializing in flowers, vegetables and sugar cane.
- Of special interest on this farm was that Mr. Dhoor is an educated young man who entered farming of his own volition (his family having been in other professions). He admitted to struggling to make ends meet on the farm but stated that he was truly happy with his choice to enter farming and hoped that his young son would follow in his footsteps.
- Of most recent account Mr. Dhoor has established a cooperative of progressive farmers, and is preparing a number of his value added products for export

4. **4.** Anand Kumar: interviewed 10/04/13, Ramgarh Village Dehradun, India

   - Regional Director Navdanya, an organization which networks with farmers to provide support, training and operates central markets for sustainable produce
   - We met on the research farm where myself and other interns were staying. Our conversation centered on the role of Navdanya as a local organization

Academics:

5. H.S. Dhaliwal: Additional Director of Extension Services, PAU: interviewed 09/09/13, PAU Ludhiana, Punjab

6. Dr. S. S. Walia: Aronomist PAU: Integrated Farming Research: interviewed 09/19/13, PAU Ludhiana, Punjab

Policy Makers & Government:

7. Dr. Sardara Singh Johl: Interviewed 9/28/13, Ludhiana Punjab

- Dr. Johl, now in his 80s has an extensive CV, having held many state, national and international posts including head of the Punjab State Planning Commission and Chancellor of PAU

- His extensive work has been highly influential in agricultural policy in India since the time of the green revolution in the 1960s

Business People, Corporate Representatives:

8. Unnamed Pepsi-co Farmer: Observation and Interview: 09/05/13 (translated by Dr. Baljinder)

- This farmer spoke with me about his involvement in the Pepsico project which was partnered with PAU to extend production contracts to farmers and provide extension services and water saving technology.
- The cash crops on this farm were rice/wheat rotation, and potatoes grown under contract with Pepsi
- Of interest is that this man's commercial farm was very conventional however his home garden was highly integrated including a biogas generator that meets all home fuel needs with cow dung from the home garden.

  -The home was extremely comfortable and the daughter was preparing to begin nursing school in NY, NY.

INFORMAL, CONVERSATIONAL & GROUP INTERVIEWS

Farmers: Integrated

1. Bapu Mahazan: interviewed 8/18/13 in Wardha, Maharashtra (Translated by Dr. Tarak Kate)

    - Integrated farm, which had- in this farmers lifetime transitioned from integrated/ organic to conventional to integrated again.
    - producing: cotton mixed with pigeon pea, papaya mixed with vegetables with the chief cash crop being papaya.
    - Farm appeared to be profitable and labor was hired, and his children (now in college) intended to take over management of the farm.

2. Unnamed Integrated Farmer: interviewed 8/23/13 in Villages Surrounding Wardha, Maharashtra (Translated by Dr. Tarak Kate)

    - Integrated farm (recently transitioned from conventional)
    - The farmer was clearly very poor and had been persuaded to integrate his farm by local farmer outreach programs molded on Ghandian philosophy of self-reliance and headed by local physicians.
    - This farm produced mixed crops of cotton, legumes, corn and vegetables
    - At the time of this interview the farm (and all surrounding villages) had been adversely affected by unseasonable monsoons.

Farmers: Conventional

3. Unnamed Conventional Farmer: interviewed 8/17/13, at Dharamitra Wardha, Maharashtra (Translated by Dr. Tarak Kate)

- This man was young, and was father to two young children
- On his farm he grew cotton and brinjal (eggplant)
- This farmer had no interest in integrating his farm, and appeared to have a very modest lifestyle

4. Unnamed Member of Sangh Milk Cooperative: interviewed 8/22/13, in Wardha Maharashtra (Translated by Dr. Tarak Kate)

- Cattle Cooperative (vertically, not horizontally integrated)
- This man's home was humble, but comfortable; his son was in college and hoped to take over the family business
- The farm produced milk which was collected by the central village distributor and then sold to households in Wardha

Academics:

5. Dr. Tarak Kate: Botanist, Ashoka Fellow and Founder of Dharamitra Research Center: Interviewed August 2013, Dharamitra Wharda, Maharashtra

- Dr. Kate is affiliated with the Sustainability Institute at the University of Stellenbosh, Stellenbosh South Africa.

- Dr. Kate's work is influenced by Ghandian philosophy and is life's work has been sustainable rural development, particularly in his hometown of Wardha, he remains committed to integrated agriculture

6. Sonali (Last name unknown): Soil Scientist Dharamitra: Interviewed August 2013, Dharamitra Wharda, Maharashtra

7. Dean Rajinder Sidhu: Agricultural economist & Dean of the College of Social Sciences and Humanities at Punjab Agricultural University: Interviewed in September 2013, in Punjab

- Dean Sidhu, has published extensively in the field of agricultural economics and is currently the youngest Dean at PAU, one of the largest agricultural universities in Asia.
- Dean Sidhu arranged all of my translators, interviews and site visits. I had ample opportunity talk with him about his work and ideas regarding my research topic.

8. Dr. Baljinder (last name unknown): Agricultural economist, PAU: Interviewed 09/05/13, in route to visit Pepsi project site, Punjab

9. Amarpreet (Last name unknown) researcher, agricultural economics PAU: Interviewed September 2013, Punjab

- Amarpreet acted as my translator during many of my interviews

10. Dr. Meherben Singh: Senior Extension Specialist PAU: Interviewed 09/09/13 at PAU, Ludhiana, Punjab

11. Gurinder Singh Mann: Punjabi Historian UCSB: Interviewed January- June 2014

Policy Makers & Government:

12. Village Council/ Head of Sangh Milk Cooperative (names unknown): Interviewed 8/22/13, villages surrounding Wardha Maharashtra

- The village council, consisting of approximately 8 men who discussed with me the details of the operation of the Sangh Milk Cooperative

Business People, Corporate Representatives:

13. Interview with Ravi Kashikar: Input supply, wholesale distributor of seed, insecticide, fertilizer and technical knowledge: interviewed 8/17/13, Wardha Maharashtra

- ‘farming is a losing proposition in India’

- Active member of the leading farmers union in the area

Other:

14. Karuna Fatune: Actavist Leader of the Women's Rural Empowerment Initiative: Interviewed 8/23/13, Wardha, Maharashtra

15. Dr. Ulhaus Jajoo: Medical Dr. and Activist for 'Holistic Rural Health': Interviewed 8/24/13, Wardha, Maharashtra

- Deeply involved in Gandhian philosophy, Dr. Jajoo has published extensively and headed the local medical college, supervising the post graduate training of numerous physicians.

16. Aparma Pallavi: Journalist *Down to Earth Magazine*, Mumbai India: Interviewed 8/27/13, Wardha Maharashtra

- Pallavi has been researching and writing about Indian food traditions for over 20 years

SURVEY

1. Unnamed farmers a Punjab Agricultural University *kisan mela* (farmers Fair): interviewed 9/13-14/13, at PAU Ludhiana, Punjab (Translated by Amarpreet)

- I surveyed more than 18 farmers during this these two days
- Most had come to PAU from the surrounding towns and villages in order to purchase new seeds and to see the latest agricultural technology on display. The theme of this fair was ‘Do not burn paddy straw’
- Farmers were farming 8-20 acres, some land was leased, some was owned, most were engaged in wheat/ paddy rotation, all were conventional although some did use a few integrated techniques (green manuring etc.) most were in debt
- Most expressed fear and dissatisfaction over conventional farming in Punjab, most wanted their children to enter other professions, and most also would be willing to leave farming if other opportunities were presented
- Of note is the fact that successful/ profitable farmers would be less inclined to attend the farmers fair in search of new techniques. This dynamic would certainly influence the interview results.

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